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U.S. Army Environmental Center

SIERRA ARMY DEPOT
Lassen County, California

Record of Decision/Remedial Action Plan
Seven Sites

Final

Contract DAAA15-90-D-0011
Task Order 2

September 1995

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MONTGOMERY WATSON

SIERRA ARMY DEPOT
LASSEN COUNTY, CALIFORNIA

FINAL
RECORD OF DECISION/REMEDIAL ACTION PLAN
SEVEN SITES

CONTRACT DAAA15-90-D-0011
TASK ORDER 3

Prepared For:

UNITED STATES ARMY
ENVIRONMENTAL CENTER
ABERDEEN PROVING GROUND, MARYLAND

Prepared By:

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September 1995

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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
BETX	benzene, ethylbenzene, toluene, and xylenes
bgs	below ground surface
BRA	baseline risk assessment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFU/g	colony-forming units per gram
COC	compounds of concern
CPF	cancer potency factor
CPT	cone penetrometer test
CRL	certified reporting limit
DCA	dichloroethene
DNB	dinitrobenzene
DNT	dinitrotoluene
DO	dissolved oxygen
DTSC	Department of Toxic Substances Control
EP	extraction procedure
ESE	Environmental Science and Engineering, Inc.
FFSRA	Federal Facility Site Remediation Agreement
GAC	granular activated carbon
HI	hazard index
HLA	Harding Lawson Associates
HMX	cyclotetramethylene tetranitramine
HQ	hazard quotient
IRFNA	inhibited red-fuming nitric acid
IRP	Installation Restoration Program
MCL	maximum contaminant level
MCLG	maximum contaminant level goals
NCP	National Contingency Plan
NPL	National Priorities List
PAH	polycyclic aromatic hydrocarbons
RAP	Remedial Action Plan
RD/RA	Remedial Design/Remedial Action
RDX	hexahydro-1,3,5-trinitro-1,3,4-triazine
RfD	reference dose
RME	reasonable maximum exposure
ROD	Record of Decision
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act
SDWS	Secondary Drinking Water Standards
SIAD	Sierra Army Depot
SVOC	semivolatile organic compound
SWRCB	State Water Resources Control Board
TAL	target analyte list
TBC	to be considered

ACRONYMS AND ABBREVIATIONS
(Continued)

TCE	trichloroethene
TCL	target compound list
THC	total hydrocarbon
TNB	trinitrobenzene
TOC	total organic carbon
TPH	total petroleum hydrocarbons
TRPH	total recoverable petroleum hydrocarbons
TVH	total volatile hydrocarbons
USAEHA	U.S. Army Environmental Hygiene Association
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compounds
WES	Waterways Experiment Station

1.0 DECLARATION

1.1 SITE NAME AND LOCATION

Seven sites at Sierra Army Depot (SIAD), Lassen County, California:

- TNT Leaching Beds Area
- Diesel Spill Area
- Old Fire-Fighting Training Facility
- Nike Missile Fuel Disposal Site A
- Nike Missile Fuel Disposal Site B
- Toxic Storage Building 578
- Unidentified Pit

1.2 STATEMENT OF BASIS AND PURPOSE

This Record of Decision (ROD)/Remedial Action Plan (RAP) presents, for the sites listed above, the selected response actions that were chosen in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA), as amended by the Superfund Amendments Reauthorization Act of 1986 (SARA), to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan (NCP), and Chapter 6.8 of the California Health and Safety Code. Further, these actions are also being taken in response to the California Water Code. This ROD/RAP explains the factual and legal basis for selecting the response actions for the seven sites. The information supporting the selected response actions is contained in the Administrative Record for these sites. The State of California, as represented by the Department of Toxic Substances Control (DTSC), Lahontan Regional Water Quality Control Board (RWQCB), and the U.S. Army (Army), concur with the selected response actions.

Section 25356.1(d) of the California Health and Safety Code requires that a RAP approved by DTSC include a non-binding preliminary allocation of financial responsibility among all identifiable potentially responsible parties. Upon consideration of all the evidence, DTSC has concluded that the preliminary non-binding allocation of financial responsibility in this ROD/RAP is as follows:

U.S. Army, Sierra Army Depot	100 percent

The content of this ROD/RAP is based on recommendations in the U.S. Environmental Protection Agency's (USEPA's) Interim Final Guidance on Preparing Superfund Decision Documents (USEPA, 1989a).

1.3 ASSESSMENT OF THE SITES

1.3.1 TNT Leaching Beds Area

The TNT Leaching Beds Area actually consists of two subsites: TNT Leaching Beds Subsite and Paint Shop Subsite. The TNT Leaching Beds Subsite is composed of two unlined depressions or leaching beds approximately 50 feet by 100 feet and 50 feet by 50 feet, respectively. These beds were used in conjunction with a shell washout facility that operated from the early 1940s to 1949, when it was demolished. Water, containing explosive compounds, flowed through a concrete-lined trough to the unlined beds where it infiltrated into the soil. Investigations conducted as part of the U.S. Army Installation Restoration Program (IRP) determined that soil and groundwater at the TNT Leaching Beds Subsite are contaminated with explosives. The Paint Shop Subsite consists of the area surrounding a concrete pad that was formerly an ammunition renovation area. A cement-lined trough extends eastward from the concrete pad towards a depression that was a drywell or settling pond. Wastewater suspected to be mixed intermittently with solvents was washed down sink and floor drains at the facility through the concrete trough and into the drywell or settling pond. Laboratory analyses indicate that soil at the Paint Shop Subsite is contaminated with volatile organic compounds (VOCs) and semivolatile organic compounds (SVOCs) and groundwater is contaminated with VOCs, primarily trichloroethene (TCE).

Actual or threatened releases of hazardous substances from the TNT Leaching Beds Area, specifically explosives, VOCs, and SVOCs in soil, and VOCs and explosives in groundwater, if not addressed by implementing the response actions selected in this ROD/RAP, may present an imminent and substantial endangerment to public health, welfare, or the environment.

1.3.2 Diesel Spill Area

A diesel oil spill was discovered at this site on March 3, 1987. The spill was the result of a small leak in an underground pipe leading from an underground storage tank. The area surrounding the former leak was excavated and restored with fill material in 1987. The underground storage tank and piping were removed August 19, 1990. Investigations conducted at the Diesel Spill Area determined that subsurface soil and groundwater are contaminated with diesel-related compounds. Diesel contamination was not found in surface soils and is limited to between 15 feet below ground surface (bgs) and the water table (approximately 62 feet bgs).

Actual or threatened releases of hazardous substances from the Diesel Spill Area, specifically diesel-related compounds in soil and groundwater, if not addressed by implementing the response action selected in this ROD/RAP, may present an imminent and substantial endangerment to public health, welfare, or the environment.

1.3.3 Old Fire-Fighting Training Facility

The Old Fire-Fighting Training Facility was initially a paved and bermed ice skating rink. It appears to have also been used as a tennis court. The site was reportedly used to train SIAD

fire-control personnel in the early 1960s. Cobalt and lead were detected at levels slightly above background in the surface soil, and arsenic, barium, iron, magnesium, manganese, and potassium were detected at levels slightly above background levels in subsurface soils. Although several metals were detected at levels slightly above calculated background concentrations, the levels detected reflect natural conditions. Therefore, no further action is recommended for this site.

1.3.4 Nike Missile Fuel Disposal Site A

The Nike Missile Fuel Disposal Site A was used for the disposal of fuel components from Nike Ajax missiles. Fuel disposal activities included the burning of aviation gasoline (JP-4) in shallow pits, and the evaporation of inhibited red-fuming nitric acid in small aluminum dishes adjacent to the burning pits. Nitrate was the only chemical detected in soil and groundwater at levels above background concentrations. However, nitrate levels in groundwater samples were significantly lower than state drinking water standard levels. Because the maximum on-site concentrations were well below values considered to pose potential risks to human health and the environment, no further action is recommended at this site.

1.3.5 Nike Missile Fuel Disposal Site B

Fuel disposal activities for the Nike Missile Fuel Disposal Site B were the same as those activities at the Nike Missile Fuel Disposal Site A. Nitrate was the only chemical detected in soil at concentrations above background. However, nitrate levels in groundwater at this site were below state drinking water standards. Because maximum concentrations were well below calculated values considered to pose potential risks to human health and the environment, no further action is recommended at this site.

1.3.6 Toxic Storage Building 578

The Toxic Storage Building 578 site consists of the area surrounding Building 578, including an adjacent drainage ditch. Building 578 is a relatively small, one-story, concrete warehouse. The concrete slab floor in the building slopes toward a centrally located drain that extends beneath the building to the east and onto an outside gravel-covered drain area. A spill of 1 quart of cyanide was reported; however, no cyanide was detected during an investigation conducted at the site. Aluminum, calcium, iron, magnesium, and sodium were detected at concentrations slightly exceeding background levels but are believed to represent natural conditions. These metals were determined to cause no potential adverse effects on human health and the environment because they were either considered essential human nutrients and/or were not appreciably toxic at the relatively low concentrations detected. Therefore, no further action is recommended at this site.

1.3.7 Unidentified Pit

The Unidentified Pit site, which is oval in shape and measures approximately 100 feet by 45 feet by 10 feet deep, was first observed by the Army during a helicopter flight over SIAD in 1989.

During a site visit in 1992, a shallow 3-foot-wide ditch was observed leading from the pit west toward Honey Lake. Subsequent investigation indicated that the pit was used as a stock tank allowing cattle to have access to water from Honey Lake. Calcium carbonate or other alkali salts that leached from the soil were observed in the bottom of the pit. Several chemicals (thallium, arsenic, and phenanthrene) were detected at levels exceeding typical surface soil concentrations. Evaporation of groundwater has caused these chemicals to naturally accumulate at higher concentrations within the pit. The Unidentified Pit was created by the excavation of native soil, which the Army has agreed to replace, thereby removing the potential for adverse exposure at the site. Therefore, no further action is recommended for this site.

1.4 DESCRIPTIONS OF THE SELECTED REMEDIES

1.4.1 Paint Shop Subsite Soil

The selected remedy will address the contaminated soil at the Paint Shop Subsite by reducing VOC and SVOC concentrations in soil.

The major components of the selected remedy are:

- Excavation of solvent-contaminated soil
- Off-site treatment and disposal of contaminated soil
- Backfill of clean soil

1.4.2 TNT Leaching Beds Subsite Soil

The selected remedy will address the contaminated soil at the TNT Leaching Beds Subsite by reducing explosives concentrations in soil.

The major components of the selected remedy are:

- Excavation of explosives-contaminated soil
- On-site composting of contaminated soil
- Backfill of composted soil

1.4.3 TNT Leaching Beds Area Groundwater

Since the TCE plume at the Paint Shop Subsite and the explosives plume at the TNT Leaching Beds Subsite overlap, remedial alternatives were developed for the combined plumes. The selected remedy will address the contaminated groundwater at the TNT Leaching Beds Area by an evaluation of natural attenuation/degradation to assess whether contaminant migration and degradation rates are within acceptable ranges.

The major components of the selected remedy are:

- Further characterization of site hydrogeology

- Evaluation of natural attenuation/degradation and contaminant migration rates
- Institutional controls
- Groundwater monitoring

In the event the selected remedy is not acceptable to the State of California or the Army, a contingency alternative will be implemented. However, if the Army does not agree with the State, the Army can invoke dispute resolution via Section 12 of the Federal Facility Site Remediation Agreement (FFSRA). The contingency alternative consists of groundwater extraction and treatment with air stripping and granular activated carbon (GAC) adsorption; treated groundwater would be disposed by reinjection or by another method that is acceptable to the State.

1.4.4 Diesel Spill Area Soil and Groundwater

The selected remedy will address the contaminated soil and groundwater at the Diesel Spill Area by reducing diesel-related compound concentrations.

The major components of the selected remedy are:

- Treatment of diesel-contaminated soil using in situ bioventing
- Treatment of diesel-contaminated groundwater using vacuum vapor extraction

1.4.5 Five Remaining Sites

As discussed in Section 1.3, no further action is recommended for the following sites:

- Old Fire-Fighting Training Facility
- Nike Missile Fuel Disposal Site A
- Nike Missile Fuel Disposal Site B
- Toxic Storage Building 578
- Unidentified Pit

1.5 STATUTORY DETERMINATIONS

1.5.1 Paint Shop Subsite Soil

The selected remedy for the Paint Shop Subsite soil satisfies the statutory requirements of CERCLA §121 and §120(a)(4), as amended by SARA, in that the following mandates are attained:

- The selected remedy is protective of human health and the environment.

- The selected remedy complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action.

- The selected remedy is cost effective.

- The selected remedy utilizes permanent solutions and alternative treatment technologies or resource recovery technologies, to the maximum extent practicable.

- The selected remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

1.5.2 TNT Leaching Beds Subsite Soil

The selected remedy for the TNT Leaching Beds Subsite soil satisfies the statutory requirements of CERCLA §121 and §120(a)(4), as amended by SARA, in that the following mandates are attained:

- The selected remedy is protective of human health and the environment.

- The selected remedy complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action.

- The selected remedy is cost effective.

- The selected remedy utilizes permanent solutions and alternative treatment technologies or resource recovery technologies, to the maximum extent practicable.

- The selected remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

1.5.3 TNT Leaching Beds Area Groundwater

The selected remedy and contingency alternative for the TNT Leaching Beds Area groundwater satisfy the statutory requirements of CERCLA §121 and §120(a)(4), as amended by SARA, in that the following mandates are attained:

- The selected remedy and contingency alternative are protective of human health and the environment.

- The selected remedy and contingency alternative comply with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action.

- The selected remedy and contingency alternative are cost effective.

- The selected remedy and contingency alternative utilize permanent solutions and alternative treatment technologies or resource recovery technologies, to the maximum extent practicable.

- The selected remedy and contingency alternative satisfy the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

Because the selected remedy and contingency alternative will result in contaminants remaining on site above the target cleanup levels during the remedial action, 5-year site reviews will apply to these actions [CERCLA §121(c) and 40 CFR 300.430 (f)(4)(ii)].

1.5.4 Diesel Spill Area Soil and Groundwater

The selected remedy for the Diesel Spill Area soil and groundwater satisfies the statutory requirements of CERCLA §121 and §120(a)(4), as amended by SARA, in that the following mandates are attained:

- The selected remedy is protective of human health and the environment.

- The selected remedy complies with federal and state requirements that are legally applicable or relevant and appropriate to the remedial action.

- The selected remedy is cost effective.

- The selected remedy utilizes permanent solutions and alternative treatment technologies or resource recovery technologies, to the maximum extent practicable.

- The selected remedy satisfies the statutory preference for remedies that employ treatment that reduces toxicity, mobility, or volume as a principal element.

Because the selected remedy will result in contaminants remaining on site above the target cleanup levels during the remedial action, 5-year site reviews will apply to these actions [CERCLA §121(c) and 40 CFR 300.430 (f)(4)(ii)].

1.5.5 Five Remaining Sites

The maximum concentrations of chemicals detected at the five remaining sites do not pose potential risks to human health and the environment and represent natural conditions. Therefore, no remedial actions are necessary to ensure protection of human health and the environment [CERCLA §121]. Because no remedial actions are necessary, no statutory determinations of remedial actions are necessary.

SIERRA ARMY DEPOT
RECORD OF DECISION/REMEDIAL ACTION PLAN

TNT LEACHING BEDS AREA
DIESEL SPILL AREA
OLD FIRE-FIGHTING TRAINING FACILITY
NIKE MISSILE FUEL DISPOSAL SITE A
NIKE MISSILE FUEL DISPOSAL SITE B
TOXIC STORAGE BUILDING 578
UNIDENTIFIED PIT

Donald D. Whitfield, II
Colonel, OD
Commander
Sierra Army Depot

19 July 95
Date

Raymond J. Fatz
Acting Deputy Assistant Secretary of the Army
(Environment, Safety, and Occupational Health)
OASA (I, L&E)

28 July 95

Anthony J. Landis, P.E.
Chief of Regional Operations
Office of Military Facilities
California Department of Toxic Substances Control

9-8-95
Date

Harold Singer
Executive Officer
California Regional Water Quality Control Board
Lahontan Region

Aug 31, 1995
Date

2.0 DECISION SUMMARY

This section of the ROD/RAP provides an overview of the site-specific factors and analyses that led to the selection of the response actions for the seven sites.

2.1 SITE NAME, LOCATION, AND DESCRIPTION

SIAD is an active military facility located in Honey Lake Valley of Lassen County in northeast California, approximately 4 miles west of the California-Nevada state border and 5 miles east of U.S. Highway 395 (Figure 2-1). The two largest communities near SIAD are Susanville, California (county seat of Lassen County, located 40 miles northwest of SIAD), and Reno, Nevada (located 55 miles southeast of SIAD). Other neighboring communities include Herlong, Sage Flats (located near the southern entrance to the main depot), and Doyle (located 8 miles south of SIAD), all in California.

The total area of SIAD, including Honey Lake which is adjacent to SIAD on the northwest border, is 96,430 acres. The Main Depot is 32,242 acres and the Upper Burning Ground, located 1 mile northeast of the Main Depot is 4,080 acres. Honey Lake, which was acquired by SIAD in 1933, encompasses 60,108 acres.

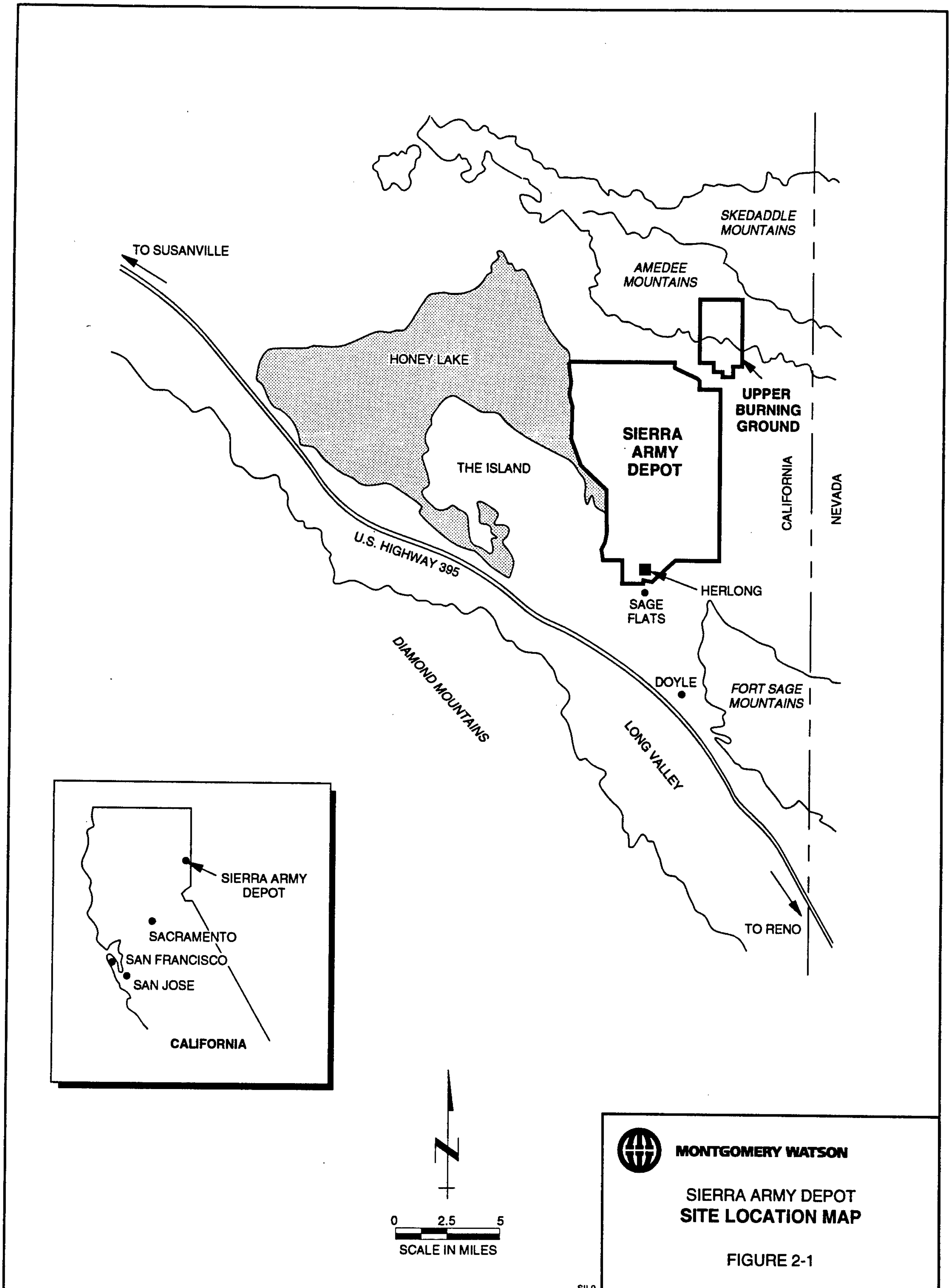
2.1.1 Physiography

Honey Lake Valley where SIAD is located is situated in the Basin and Range physiographic province. The area is characterized by northwest trending mountains that rise 2,000 to 3,000 feet above the valley floor. The valley is bordered on the southeast by the Fort Sage and Virginia Mountains, on the northeast by the Skedaddle and Amedee Mountains, on the southwest by the Diamond Mountains, and on the north by the Shaffer Mountains. The Amedee, Diamond, and Fort Sage Mountains are proximate to SIAD. The main depot has little topographic relief and varies in elevation from 3,986 feet at lake level to approximately 4,134 feet above mean sea level (msl) at Herlong, California. The southern portion of the main depot lies on a sandy terrace and is somewhat higher in elevation than the northern part, which lies on the lower lake levels. The Upper Burning Ground, a detached area of SIAD located on the edge of the Amedee Mountains, is located on rugged terrain with considerably more topographic relief than the main depot. The Upper Burning Ground ranges in elevation from 4,039 feet to 5,480 feet above msl (Benioff et al., 1988).

2.1.2 Geology of Honey Lake Basin

Honey Lake Valley lies at the junction of three geologic provinces: the western edge of the Basin and Range, the northeastern edge of the Sierra Nevada, and the southeastern edge of the Modoc Plateau. A northwest-trending fault system, the Walker Lane, extends from Las Vegas to Honey Lake Valley.

Honey Lake Valley is underlain by unconsolidated to semiconsolidated sediments and volcanic rocks overlying granitic bedrock. Granitic bedrock forms the lower impermeable boundary to



MONTGOMERY WATSON

SIERRA ARMY DEPOT
SITE LOCATION MAP

FIGURE 2-1

groundwater flow and is 5,000 to 6,000 feet below ground surface (Handman et al., 1990). Unconsolidated and semiconsolidated Pliocene and Holocene basin-fill deposits underlie, interfinger with, and overlie the consolidated volcanic rocks along the entire north and northeast margins of the basin. These semiconsolidated deposits consist of thick layers of volcanic tuff and ash that typically were deposited in shallow lakes along the lacustrine and fluvial deposits of clay, silt, and minor amounts of sand. The unit comprises the majority of the basin fill.

Honey Lake occupies part of an area previously covered by a much larger, prehistoric water body known as Lake Lahontan. Quaternary lacustrine deposits of sands and gravels predominate in the western portions of the basin, and silts and clays predominate in the eastern side of the basin.

Alluvial fans of Quaternary age consisting of poorly sorted deposits ranging in size from clay to boulders have accumulated along the base of the mountain fronts. The distal portions of the fans interfinger with the predominantly fine-grained lake deposits toward the center of the basin.

2.1.3 Surface Water Resources

More than 40 streams flow from the Diamond, Fort Sage, and Virginia Mountains and the northern volcanic uplands towards the center of the topographically closed basin. The largest streams in the basin are the Susan River and Baxter Creek, which enter the valley from the northeast, and Long Valley Creek, which enters the valley from the southeast. With the exception of the Susan River, all of these streams are intermittent and only reach the valley floor in the wet years (USDI, 1954). No surface drainage traverses the main depot of SIAD. Three intermittent streams drain off the Upper Burning Ground to terminate in the region between this area and the main depot. The most prominent surface water feature in the basin is Honey Lake, which has a large seasonal fluctuation in area and volume.

No intermittent or perennial surface water features are present in the vicinity of the seven sites discussed in this ROD/RAP, with the exception of the Unidentified Pit. The fluctuating high water line of Honey Lake is within 1,000 feet of the Unidentified Pit, as depicted on a 1984 aerial photograph of the site (Figure 4.5 in HLA, 1994).

2.1.4 Groundwater Resources

Recharge to the groundwater system in Honey Lake Valley is from direct infiltration of precipitation and snow melt into consolidated rock and unconsolidated basin fill deposits, infiltration of water from streams, seepage of irrigation water, and subsurface inflow from adjacent areas. The major sources are direct infiltration of precipitation in upland areas and infiltration of stream flow in alluvial fan areas.

The depth to the water table at SIAD is variable. The extreme heterogeneity of the sediments can influence water table elevations, and lenses of less permeable sediments may support an elevated or perched water table in some locations.

Using groundwater levels recorded in August 1993 from monitoring wells and piezometers installed during previous investigations, the 1990 Group I RI, 1991 Group II RI, 1992 Group I Follow-Up RI, and 1993 Group I and II Follow-Up RI, water-table contour maps have been constructed. The groundwater gradient across the southern portion of the main depot generally trends to the north-northwest at about 0.0005 to 0.002. The gradient in the northern portion of the main depot is essentially flat.

The regional groundwater gradient in the vicinity of the TNT Leaching Beds Area and Diesel Spill Area is essentially flat. Groundwater-level data collected from the 13 water table monitoring wells at these two sites show that the groundwater flow is primarily northwards at an average gradient of approximately 0.003, with localized gradients ranging from 0.001 to 0.01. The depth to groundwater at these sites is approximately 62 feet. Groundwater at the TNT Leaching Beds Area and Diesel Spill Area is not currently used for potable water supply.

The regional groundwater flow in the vicinity of the Old Fire-Fighting Training Facility is to the north or northeast; the gradient is essentially flat, and the depth to groundwater is estimated to be 120 feet. Public water-supply wells are located in this vicinity. The cone of depression created by pumping in the nearby public water-supply wells may affect the gradient so that local groundwater flows towards the wells (Environmental Science & Engineering, Inc. [ESE], 1983; U.S. Army Toxic and Hazardous Materials Agency [USATHAMA], 1979).

The regional groundwater gradient in the vicinity of the Nike Missile Fuel Disposal Site A is oriented to the west and is essentially flat. Groundwater was encountered at depths of 15 and 16.5 feet in two monitoring wells installed on the western boundary of the site. Groundwater at this site is not currently used for public water supply.

The regional groundwater gradient in the vicinity of the Nike Missile Fuel Disposal Site B is oriented to the west and is essentially flat. Groundwater was encountered at depths ranging from 17 to 20 feet during the drilling of soil borings and the installation of two monitoring wells at the site. Groundwater at this site is not currently used for public water supply.

The regional groundwater gradient in the vicinity of the Toxic Storage Building 578 is oriented to the west and is essentially flat. Groundwater was encountered at approximately 18 feet below ground surface during the drilling of a soil boring at the site. Groundwater at this site is not currently used for public water supply.

The regional groundwater gradient in the vicinity of the Unidentified Pit is oriented to the west and is essentially flat. Groundwater was encountered at approximately 1.5 feet below the bottom of the pit (i.e., approximately 11.5 feet below surface grade) during the drilling of soil borings at the site. Groundwater at the Unidentified Pit is not currently used for public water supply.

2.1.5 Biota

2.1.5.1 Vegetation. SIAD encompasses approximately 37,060 acres of a dried salt lake bed and volcanic terrain located to the east of Honey Lake. The principal plant community at

SIAD is greasewood-sagebrush, characteristic of the alkaline soils and semiarid climate of the area. The most common shrubs are greasewood, sagebrush, rabbit brush, spring hopsage, horsebrush, Mormon tea, and shadscale. The principal grasses include Great Basin wild, rye, saltgrass, squirrel tail, and annual cheatgrass. Common forbs include poverty weed, pepperwood, and tansy mustard. Several tree species have been introduced on base, including Chinese elm, Russian olive, Englemann spruce, Ponderosa pine, junipers, and cottonwoods, in order to decrease erosion. No threatened or endangered species are known to occur on base.

2.1.5.2 Wildlife. A variety of wildlife species is found in the general area of SIAD. Included among the species inventory for this area are four species of rabbits, 29 species of rodents, mountain lions, fox, mule deer, various reptiles and amphibians, and over 100 species of birds. From this diverse group, the Aleutian goose, mule deer, peregrine falcon, bald eagle, and game bird species are the most significant from an ecological assessment viewpoint. Mule deer and game birds are recreationally important species, while peregrine falcons, bald eagles, and Aleutian geese are rare, threatened, or endangered species.

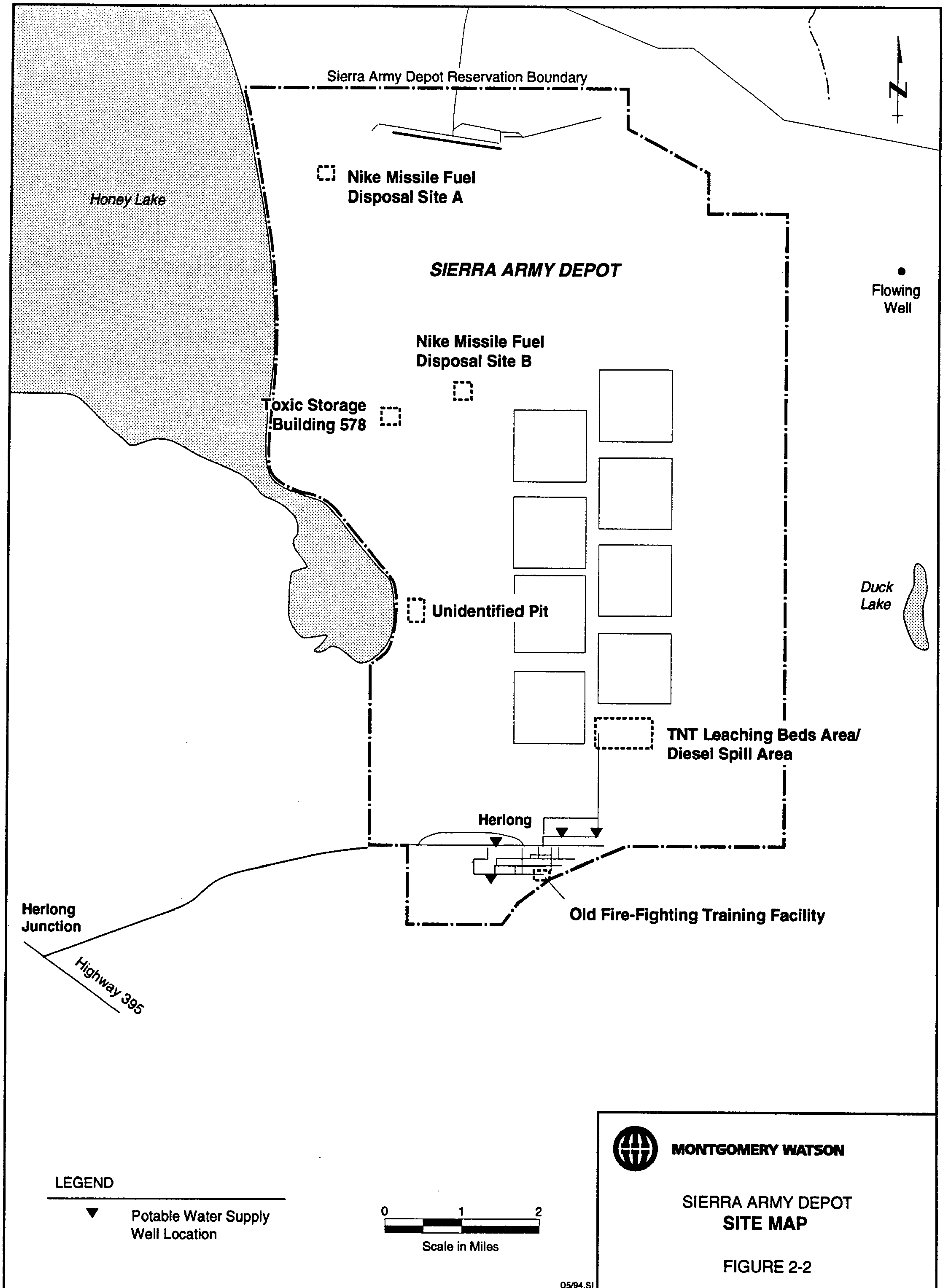
2.1.6 Land Use

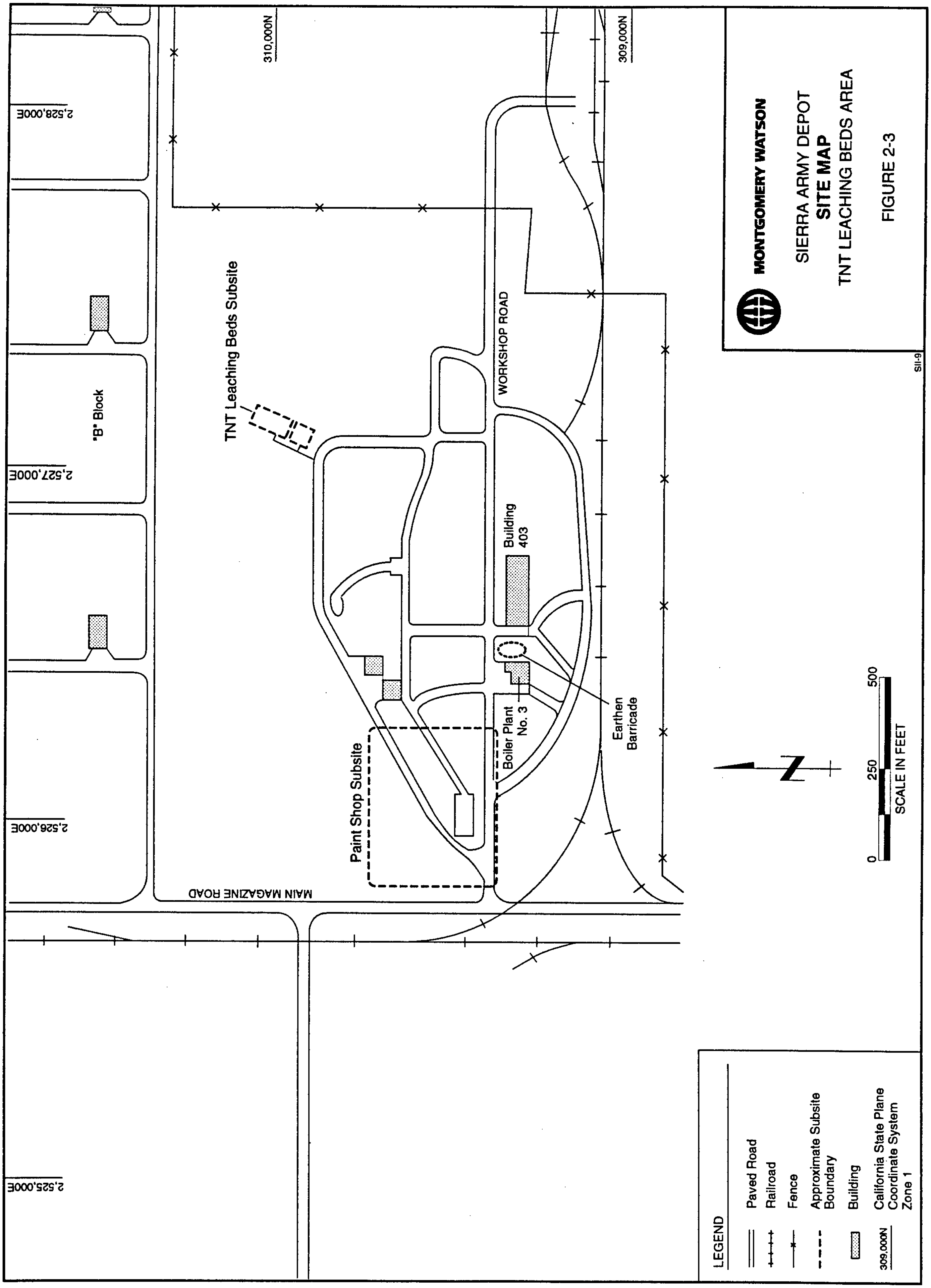
Lassen County has prepared a series of area plans covering selected portions of the county. SIAD is located within the Wendel Planning Area. Because of limited development and the sparse population, only four basic land-use categories are found in this planning area: grazing lands/open space, SIAD, irrigated lands, and town area. The largest land-use category is grazing lands/open space; most of the land is covered with native vegetation. Most of this land is in public ownership, with some land privately held. SIAD comprises approximately one-third of the total Wendel Planning Area. A few isolated patches of irrigated fields are found in the planning area. These are mainly irrigated pastures of mixed grasses and native grasses. Residences associated with ranching are included in some of these areas. The fourth category comprises the towns of Wendel, Herlong, and Sage Flats. Wendel is located northwest of SIAD; Herlong and Sage Flats are located to the southwest of SIAD near the southern entrance to the main depot (Figure 2-1). The planning area also contains Doyle State Wildlife Area, a wintering habitat for mule deer, located just south of SIAD.

2.1.7 TNT Leaching Beds Area

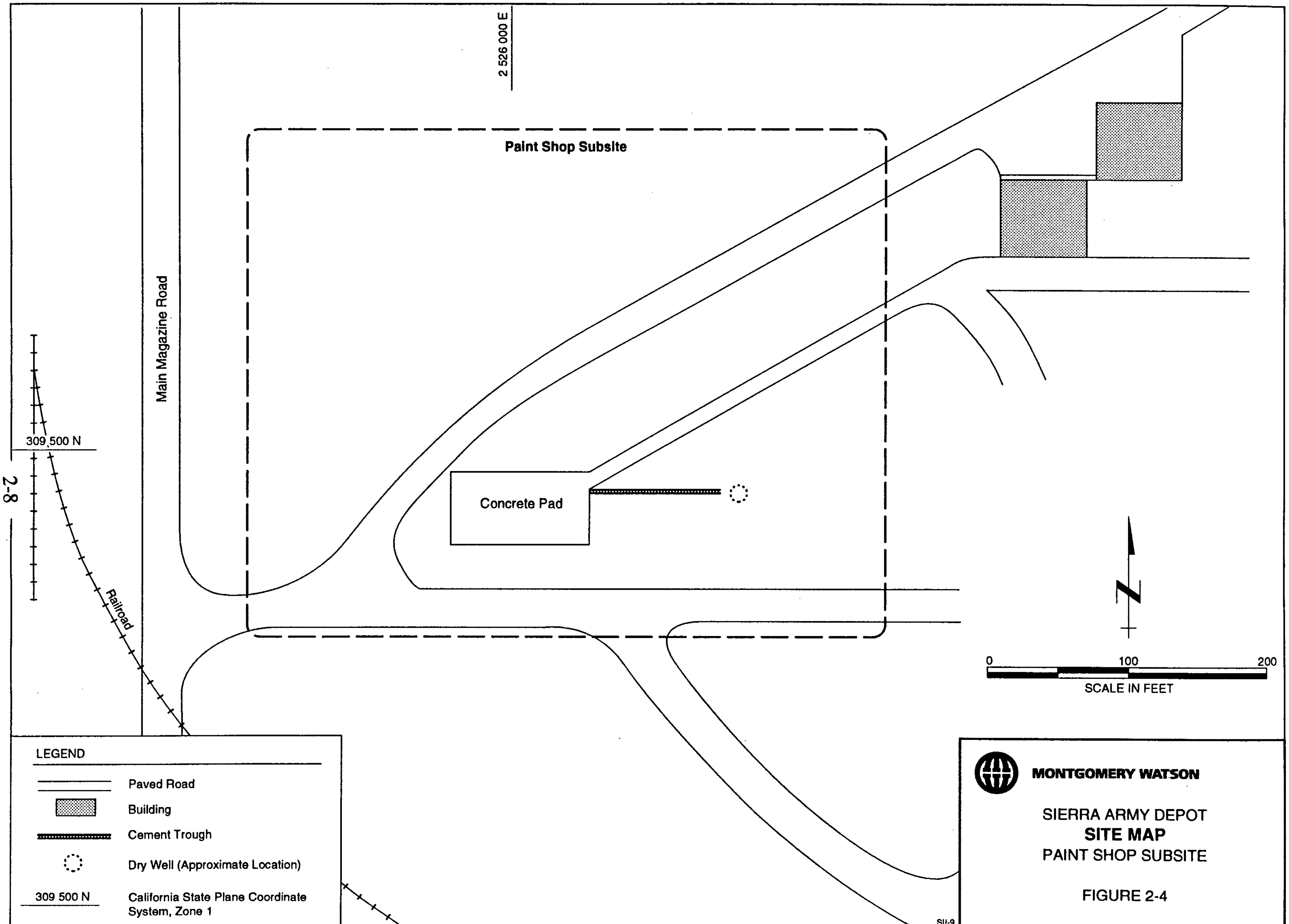
The TNT Leaching Beds Area is located in the southeastern portion of the depot (Figure 2-2). As discussed previously, the TNT Leaching Beds Area consists of two subsites: Paint Shop Subsite and TNT Leaching Beds Subsite.

The Paint Shop Subsite is located within the western portion of the TNT Leaching Beds Area (Figure 2-3). A building near the center of the subsite was used as a paint shop from the 1940s until the site was deactivated in the mid-1950s (Ryan, 1990) (Figure 2-3). The Paint Shop Subsite building was demolished; only the concrete foundation of the building remains. The Paint Shop Subsite consists of the area surrounding a concrete pad that was formerly an ammunition renovation area (Figures 2-3 and 2-4). A cement-lined trough extends eastward from the concrete pad towards a depression that was a drywell or settling pond. Wastewater


Sierra Army Depot Reservation Boundary
Honey Lake
Nike Missile Fuel Disposal Site A
SIERRA ARMY DEPOT
Flowing Well
Nike Missile Fuel Disposal Site B
Toxic Storage Building 578
Unidentified Pit
Duck Lake
TNT Leaching Beds Area/ Diesel Spill Area
Herlong
Old Fire-Fighting Training Facility
Herlong Junction
Highway 395
LEGEND
Potable Water Supply Well Location
0
1
2
Scale in Miles
05/94.SI
MONTGOMERY WATSON
SIERRA ARMY DEPOT
SITE MAP
FIGURE 2-2



MONTGOMERY WATSON
SIERRA ARMY DEPOT
SITE MAP
TNT LEACHING BEDS AREA
FIGURE 2-3
SII-9
TNT Leaching Beds Subsite
Paint Shop Subsite
"B" Block
WORKSHOP ROAD
MAIN MAGAZINE ROAD
Building 403
Boiler Plant No. 3
Earthen Barricade
310,000N
309,000N
2,528,000E
2,527,000E
2,526,000E
2,525,000E
0
250
500
SCALE IN FEET
LEGEND
Paved Road
Railroad
Fence
Approximate Subsite Boundary
Building
309,000N
California State Plane Coordinate System Zone 1



MONTGOMERY WATSON

SIERRA ARMY DEPOT
SITE MAP
PAINT SHOP SUBSITE

FIGURE 2-4

suspected to be mixed intermittently with solvents was washed down sink and floor drains at the facility through the concrete trough and into the drywell or settling pond.

The TNT Leaching Beds Subsite is located on the east side of the Main Magazine Road along Workshop Road (Figure 2-3). This subsite is composed of two unlined depressions or leaching beds approximately 50 feet by 100 feet and 50 feet by 50 feet, respectively. These beds were used in conjunction with a shell washout facility that operated from the early 1940s to 1949, when it was demolished. Water, containing explosive compounds, flowed through a concrete-lined trough to the unlined beds where it infiltrated into the soil.

2.1.8 Diesel Spill Area

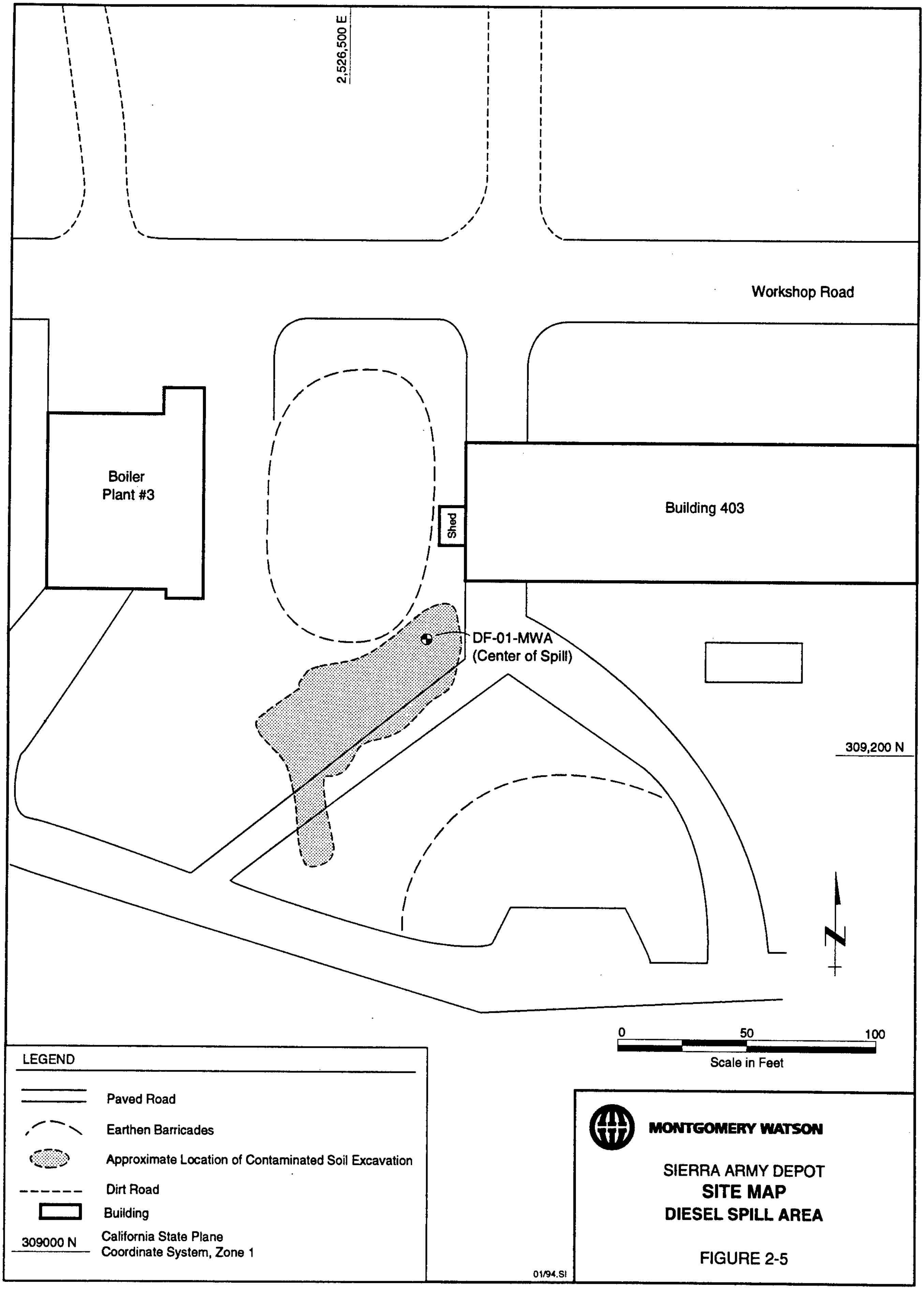
The Diesel Spill Area is located in the southeastern portion of the depot near the southwest corner of Building 403 where a diesel oil spill was discovered on March 3, 1987 (Figures 2-2 and 2-5). The spill was the result of a small leak in an underground pipe that led from an underground storage tank located directly south of Boiler Plant No. 3 to a small boiler in Building 403. Building 403 is an active ammunition renovation facility. The area surrounding the former leak was excavated and restored with fill material in 1987. The ground surface outside the paved road leading to Building 403 consists mostly of unvegetated soil. There is currently no evidence of the diesel oil spill, tanks, or piping at the ground surface. The underground storage tank and piping were removed on August 19, 1990, and Boiler Plant No. 3 has been abandoned.

2.1.9 Old Fire-Fighting Training Facility

The Old Fire-Fighting Training Facility is located at the southern boundary of SIAD between Tahoe Avenue and Pacific Street in Herlong, as shown in Figures 2-2 and 2-6. The site currently consists of an open field measuring approximately 1,000 feet along Tahoe Avenue and 300 feet wide at the center. The central portion of the site contains an asphalt-paved area measuring approximately 190 feet long by 110 feet wide. The edge of the paved area is bordered by a 2-foot-high berm of soil. Two interior berms run north to south within the paved area and divide it into three approximately equal parts. Sagebrush is present surrounding, as well as within, the paved area. The site is currently unused and aerial photographs dated July 13, 1984, show this site in its present physical form.

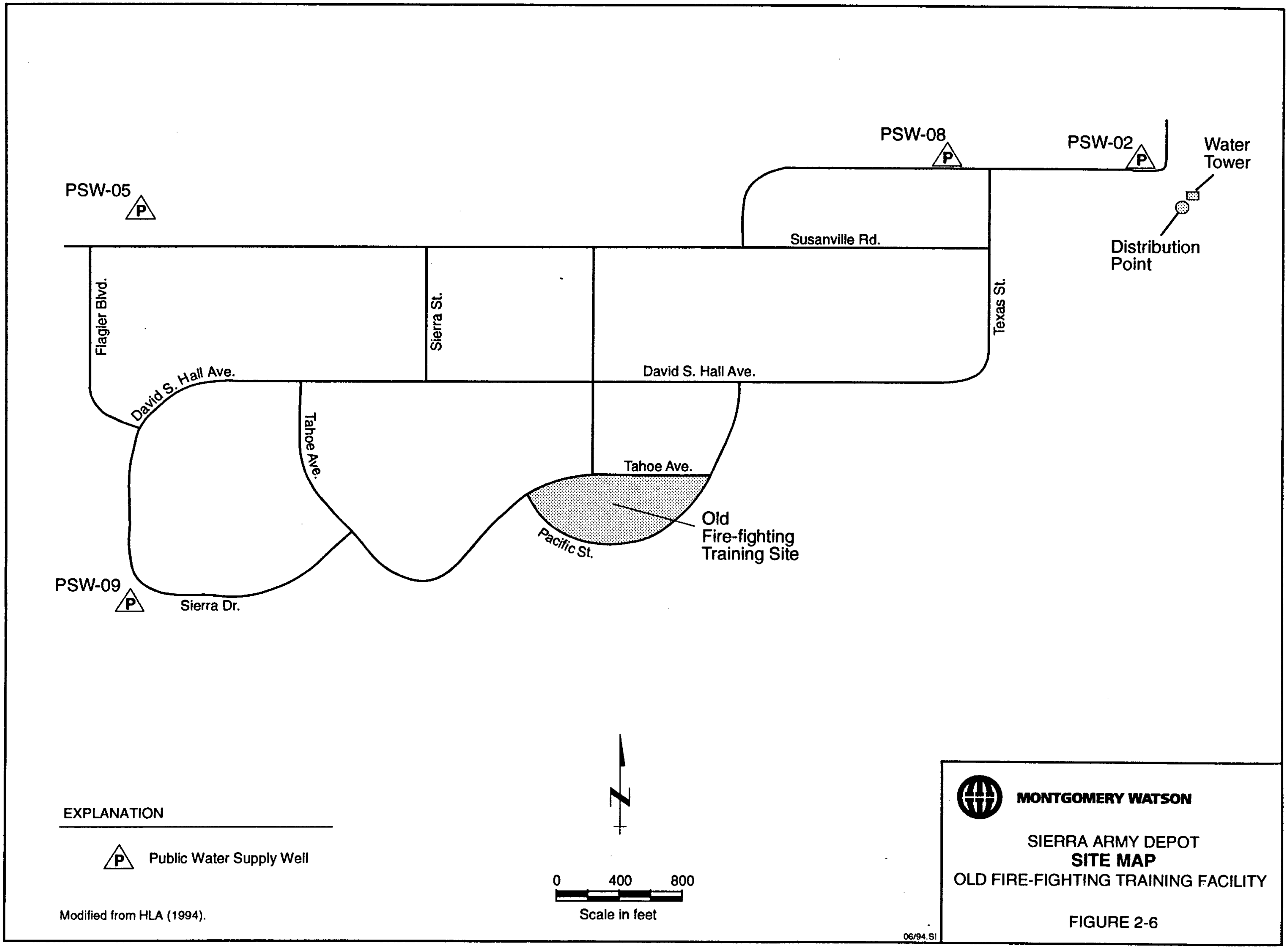
2.1.10 Nike Missile Fuel Disposal Site A

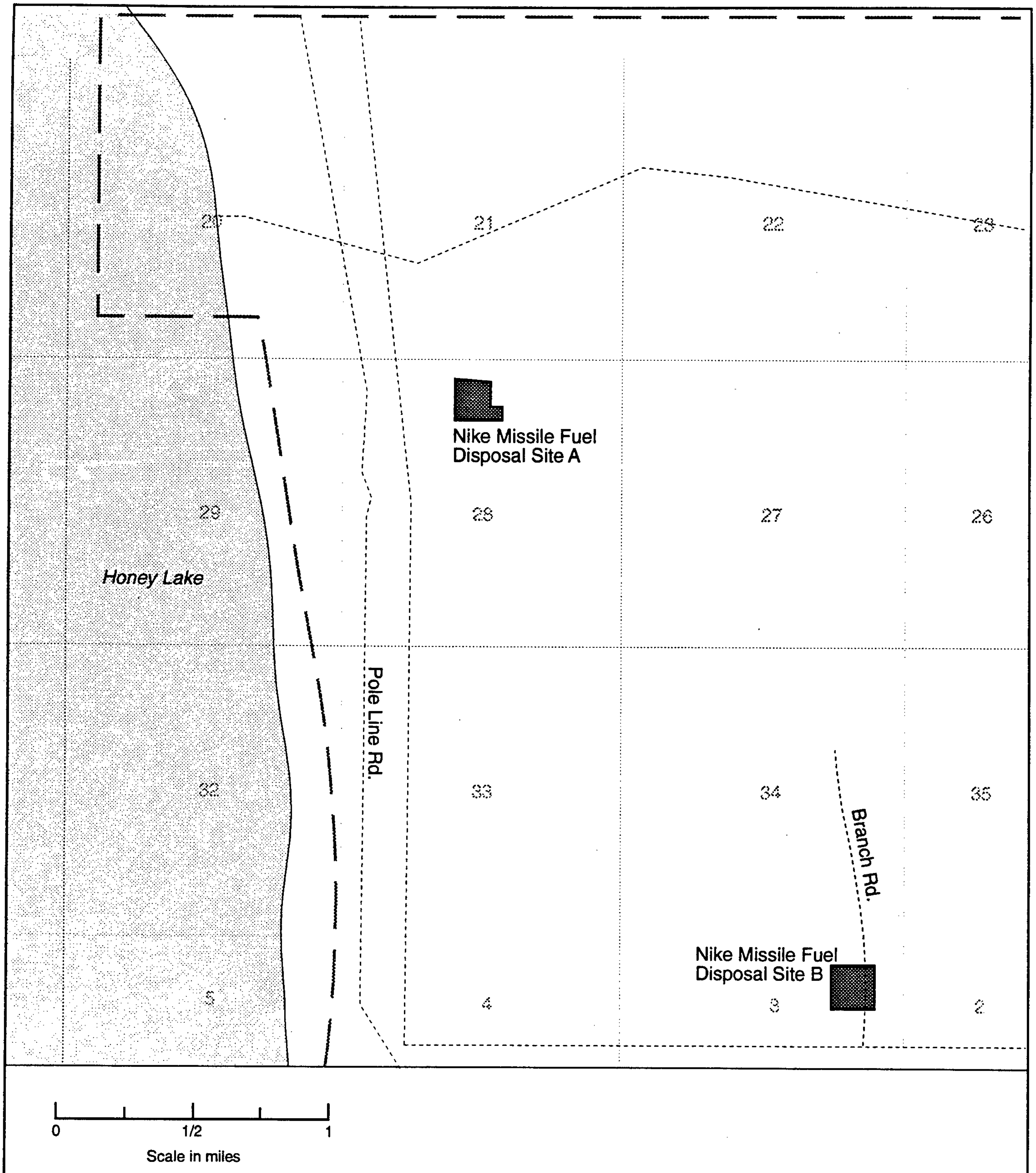
This site is located in the northwest portion of the Main Depot, east of Pole Line Road (Figures 2-2 and 2-7). The site is a relatively flat and barren open area supporting limited grassy vegetation and covers an area measuring approximately 800 feet by 900 feet. The site was used for the disposal of fuel components from Nike Ajax missiles. Fuel disposal activities included the burning of aviation gasoline (JP-4) in shallow pits, and the evaporation of inhibited red-fuming nitric acid in small aluminum dishes adjacent to the burning pits. Sagebrush surrounds the site and delineates its boundary. The site is currently unused.



SIERRA ARMY DEPOT
SITE MAP
DIESEL SPILL AREA

FIGURE 2-5


PSW-05
PSW-08
PSW-02
PSW-09
P
Water Tower
Distribution Point
Susanville Rd.
Flagler Blvd.
Sierra St.
Texas St.
David S. Hall Ave.
David S. Hall Ave.
Tahoe Ave.
Tahoe Ave.
Pacific St.
Sierra Dr.
Old Fire-fighting Training Site
EXPLANATION
Public Water Supply Well
Modified from HLA (1994).
0
400
800
Scale in feet
06/94.SI
MONTGOMERY WATSON
SIERRA ARMY DEPOT
SITE MAP
OLD FIRE-FIGHTING TRAINING FACILITY
FIGURE 2-6



EXPLANATION

- - —— Sierra Army Depot Boundary

--------- Unpaved Road

Sources: Base Map USGS, 1964; USATHAMA MEP, 1988
Modified from HLA (1994).

06/94.SI

MONTGOMERY WATSON

SIERRA ARMY DEPOT
SITE MAP
NIKE MISSILE FUEL DISPOSAL
SITES A AND B

FIGURE 2-7

2.1.11 Nike Missile Fuel Disposal Site B

This site is located in the west-central portion of the Main Depot on Branch Road (Figures 2-2 and 2-7). This site is relatively flat and barren and measures approximately 1,000 feet by 1,000 feet. Fuel disposal activities at this site were the same as those activities at the Nike Missile Fuel Disposal Site A. Sagebrush surrounds the site and delineates its boundary. The site is currently unused.

2.1.12 Toxic Storage Building 578

This site is located in the west-central portion of the Main Depot (Figures 2-2 and 2-8). The site includes the area surrounding Building 578, including an adjacent drainage ditch. Building 578 is a relatively small, one-story, concrete warehouse. The concrete slab floor in the building slopes toward a centrally located drain that extends beneath the building to the east and onto an outside gravel-covered drain area. There are no written records available regarding the quantities and types of materials previously stored in Building 578.

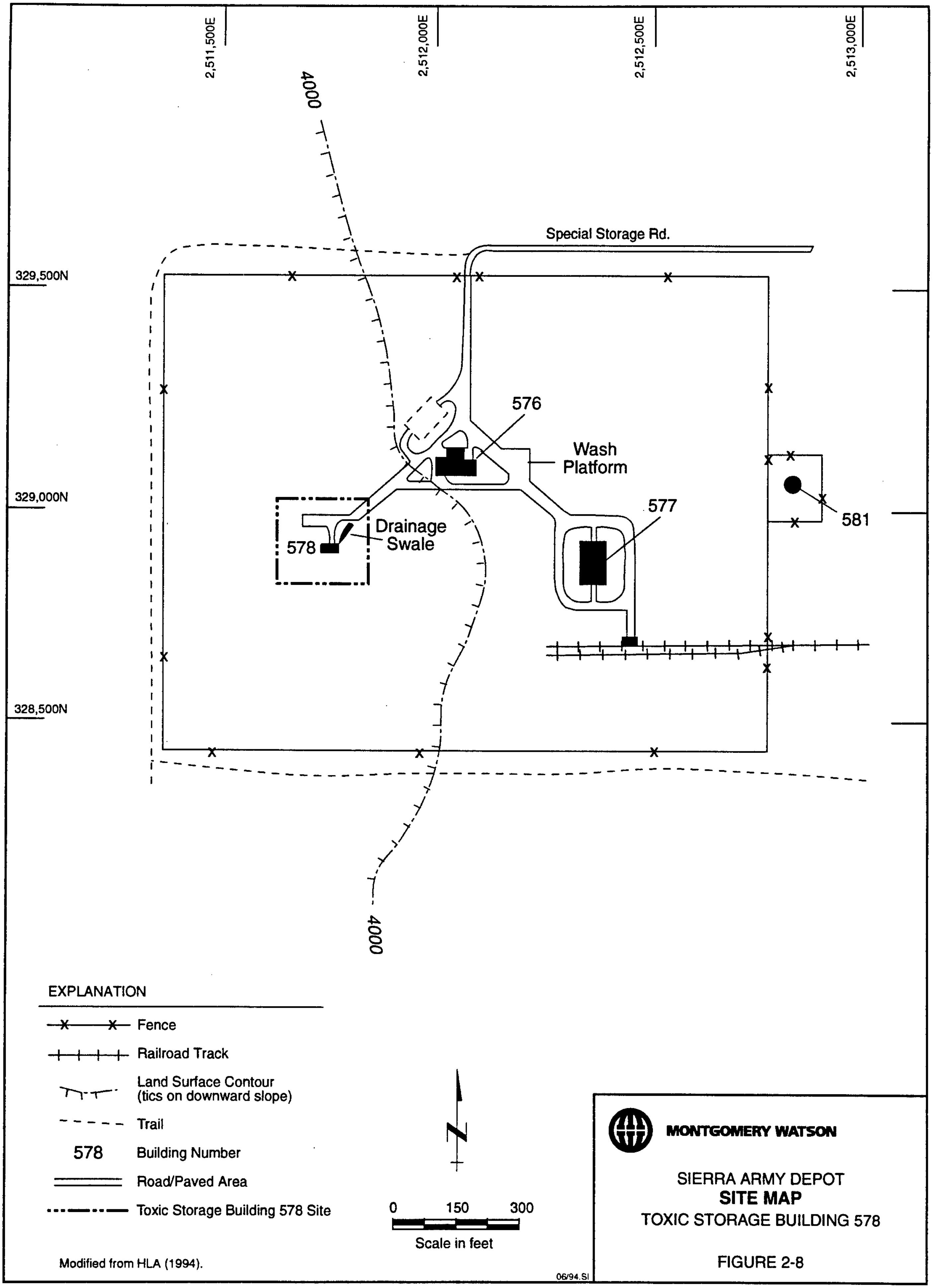
2.1.13 Unidentified Pit

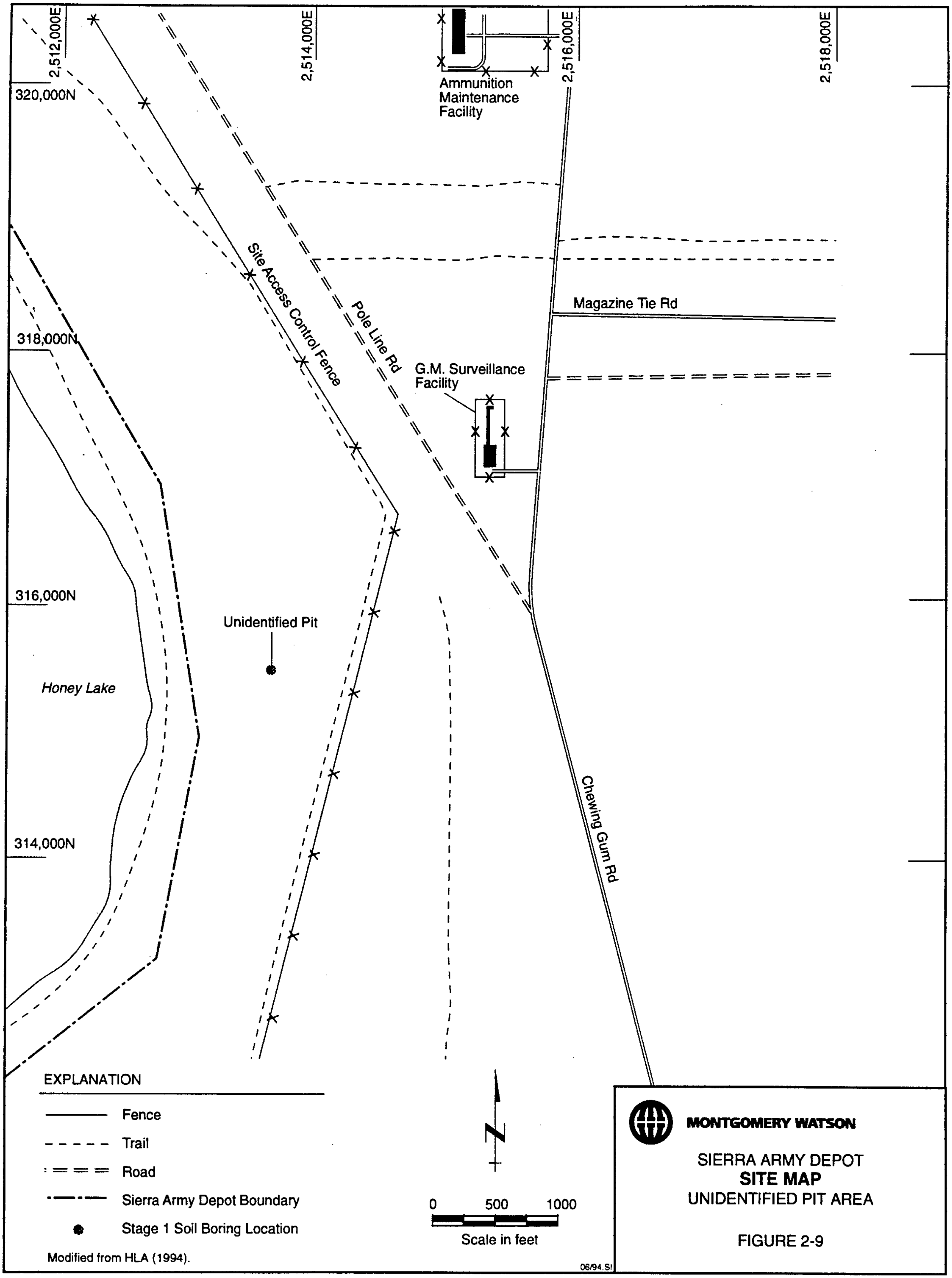
This site is located adjacent to Honey Lake outside the installation access control fence in the southwest portion of the Main Depot (Figures 2-2 and 2-9). This pit, which is oval in shape and measures approximately 100 feet by 45 feet by 10 feet deep, was observed by the Army during a helicopter flight over SIAD in 1989. No information or details regarding previous uses of the pit were known prior to the field investigation performed at the site in 1993. During a site visit in 1992, a shallow 3-foot-wide ditch was observed leading from the pit west toward Honey Lake. Subsequent investigation indicated that the pit was used as a stock tank allowing cattle to have access to water from Honey Lake. Calcium carbonate or other salts that leached from the soil were observed in the bottom of the pit.

2.2 SITE HISTORY AND ENFORCEMENT ACTIVITIES

SIAD began operations in 1942 including the reserve storage of inert supplies and materials owned by the U.S. Treasury Department. After construction of the Igloo Storage Area at SIAD, the receipt, storage, and issue of explosives was assigned to the depot. In 1954, additional missions of receipt, storage, and issue of guided missiles and propellant fuels were also assigned to SIAD. The current missions of SIAD are to receive, store, issue and renovate munitions; and to efficiently and safely demilitarize surplus ammunition. It also provides storage and maintenance of operational stocks and tactical support systems. All operations are conducted in accordance with approved environmental guidelines.

In 1991, SIAD signed an FFSRA with the California Department of Health Services, Toxic Substances Control Program (now the DTSC) and the California Regional Water Quality Control Board-Lahontan Region (RWQCB). The purpose of the FFSRA is to establish procedures and schedules for investigation and remediation of contamination and facilitate cooperation and


2,511,500E
2,512,000E
2,512,500E
2,513,000E
329,500N
329,000N
328,500N
4000
4000
Special Storage Rd.
576
Wash
Platform
577
581
578
Drainage
Swale
EXPLANATION
Fence
Railroad Track
Land Surface Contour
(tics on downward slope)
Trail
578 Building Number
Road/Paved Area
Toxic Storage Building 578 Site
0 150 300
Scale in feet
Modified from HLA (1994).
06/94.SI
MONTGOMERY WATSON
SIERRA ARMY DEPOT
SITE MAP
TOXIC STORAGE BUILDING 578
FIGURE 2-8


2,512,000E
2,514,000E
2,516,000E
2,518,000E
320,000N
318,000N
316,000N
314,000N
Ammunition Maintenance Facility
Site Access Control Fence
Pole Line Rd
Magazine Tie Rd
G.M. Surveillance Facility
Unidentified Pit
Honey Lake
Chewing Gum Rd
EXPLANATION
Fence
Trail
Road
Sierra Army Depot Boundary
Stage 1 Soil Boring Location
Modified from HLA (1994).
0
500
1000
Scale in feet
06/94.SI
MONTGOMERY WATSON
SIERRA ARMY DEPOT
SITE MAP
UNIDENTIFIED PIT AREA
FIGURE 2-9

exchange of information. There have been no enforcement actions at the seven sites discussed in this ROD/RAP.

2.2.1 TNT Leaching Beds Area

2.2.1.1 Paint Shop Subsite. A building near the center of the Paint Shop Subsite was used as a paint shop from the 1940s until the site was deactivated in the mid-1950s (Ryan, 1990) (Figure 2-3). The Paint Shop building was demolished and only the concrete foundation of the building remains. Based on observation of the site, some liquid wastes typically used in painting such as fuels, paint sludges, and solvents may have been discharged to the soils in the immediate area. A concrete trough that extends eastward from the building foundation (Figure 2-4) may have carried liquid wastes to a low-lying area about 100 feet east of the concrete pad. Volumes of chemicals used, as well as disposal practices at the Paint Shop Subsite, are unknown.

Several investigations have been conducted at the Paint Shop Subsite. The dates, type of studies, and organizations involved in these are:

- Groundwater Contamination Migration Study, U.S. Army Environmental Hygiene Agency (USAEHA, 1987);
- Phase II Groundwater Consultation, U.S. Army Environmental Hygiene Agency (USAEHA, 1988);
- IRP 1990 Group I Remedial Investigation, James M. Montgomery, Consulting Engineers, Inc. (JMM) and E. C. Jordan (JMM and E. C. Jordan, 1991b;
- IRP 1992 Group I Follow-Up Remedial Investigation, Montgomery Watson (Montgomery Watson, 1993a);
- IRP Feasibility Studies, James M. Montgomery, Consulting Engineers, Inc., (JMM and E. C. Jordan, 1991a; Montgomery Watson, 1993b; 1993c).

USAEHA installed eight monitoring wells, TNT-03- through TNT-10-MWA, at the TNT Leaching Beds Area in November 1986 (USAEHA, 1987). TNT-10-MWA was located northeast of the Paint Shop Subsite. Groundwater samples collected from wells in the vicinity of the Paint Shop Subsite were found to contain elevated levels of TCE, carbon tetrachloride, and 1,2-dichloroethane.

The 1988 site investigation consisted of installing four additional monitoring wells in the vicinity of the Paint Shop Subsite to help determine the source of TCE contamination in one monitoring well, TNT-10-MWA (USAEHA, 1988). Of these wells, TNT-11-MWA, was installed immediately to the southwest of the former paint shop. The analyses of groundwater samples collected from these monitoring wells indicated the likelihood of a VOC source other than the TNT leaching beds (Benioff et al., 1988).

The focus of the 1990 Group I RI conducted at the Paint Shop Subsite was to determine a source of TCE in the groundwater beneath the site. The investigation included a soil-gas survey, drilling and sampling of soil borings, and sampling and analysis of groundwater (JMM and E.C. Jordan, 1991b). The results of the soil-gas survey outlined an area of elevated soil gas VOC concentrations near the Paint Shop Subsite, indicating that the former paint shop is the VOC source for the area.

Activities for the 1992 Group I Follow-Up RI included soil-gas and geophysical surveys, shallow soil borings with the use of a mobile laboratory for soil sample screening, two soil borings, and sampling and analysis of groundwater (Montgomery Watson, 1993a).

2.2.1.2 TNT Leaching Beds Subsite. The two TNT leaching beds were used for disposal of wastewater from a shell washout facility. The shell washout facility, used to demilitarize TNT projectiles, was constructed in the 1940s and torn down in 1949 (ESE, 1983; USAEHA, 1988). Flushed-out explosives were washed to a flaker-dryer to reclaim TNT; the remaining water was sluiced through a concrete trench to the TNT leaching beds (ESE, 1983). Within the leaching beds, water was allowed to evaporate and infiltrate into the soils. At maximum operation, the washout plant could process 800 105-millimeter (mm) shells per day. During operation of the washout facility and leaching beds, the leaching beds were cleaned infrequently by shoveling out material that was readily reclaimable and disposing of it at the lower burning/demolition grounds. During a reassessment survey of SIAD, staining was observed within the leaching beds and also in surface soils up to a distance of 18 meters northeast of the leaching beds. The staining outside the leaching beds was presumed to be caused by wind action but could also be caused by the excavation and disposal of material from inside the leaching beds (ESE, 1983).

Several investigations have been conducted at the TNT Leaching Beds Subsite. The dates, type of studies, and organizations involved in these are:

- Phase I Hazardous Waste Study, USAEHA (USAEHA, 1984; 1985)
- Groundwater Contamination Migration Study, U.S. Army Environmental Hygiene Agency (USAEHA, 1987);
- IRP 1990 Group I Remedial Investigation, James M. Montgomery, Consulting Engineers, Inc. (JMM) and E. C. Jordan (JMM and E. C. Jordan, 1991b);
- IRP 1992 Group I Follow-Up Remedial Investigation, Montgomery Watson (Montgomery Watson, 1993a);
- IRP Feasibility Studies, JMM and Montgomery Watson, (JMM and E. C. Jordan, 1991a; Montgomery Watson, 1993b; 1993c).

In 1984, USAEHA conducted a hazardous waste study at the TNT Leaching Beds Subsite to investigate the potential for hazardous waste contamination (USAEHA, 1984). Soil contamination at the TNT Leaching Beds Subsite was evaluated by collecting eight composite

surface soil samples and by sampling the soils at various depths in six soil borings. The study identified the inactive TNT leaching beds as a site with significant levels of explosives contamination in the unsaturated zone. As a result, two monitoring wells were installed in August 1985 (USAEHA, 1985) and eight wells were installed in November 1986 (USAEHA, 1987).

The 1990 Group I RI at the TNT Leaching Beds Subsite included a soil-gas survey, surface soil sampling, drilling and sampling of soil borings, and sampling and analysis of groundwater (JMM and E.C. Jordan, 1991b).

The 1992 Group I Follow-Up RI at the TNT Leaching Beds Subsite consisted of collecting 22 composite surface soil samples in a grid surrounding the TNT leaching beds (Montgomery Watson, 1993a). Samples were concentrated in the area to the north of the leaching beds where red soil staining indicative of weathered TNT was observed. Explosives were detected in 10 of 22 composite surface soil samples.

2.2.2 Diesel Spill Area

The diesel oil spill was discovered on March 3, 1987. The spill was the result of a leak in an underground pipe that led from an underground storage tank located directly south of Boiler Plant No. 3 to a small boiler in Building 403. Building 403 is an active ammunition renovation facility. The area surrounding the former leak was excavated, the excavation lined with plastic, and restored with fill material in 1987. The excavation was stopped at 30 feet because it threatened to undermine the foundation of Building 403 (Benioff et al., 1988). Soil samples were collected at 10 locations on April 16, 1987 and June 22, 1987, and two locations on July 29, 1987. The samples were analyzed for oil and grease. The underground storage tank and piping were removed August 19, 1990, and Boiler Plant No. 3 has been abandoned.

Other investigations conducted at the Diesel Spill Area are:

- IRP 1991 Group II Remedial Investigation, James M. Montgomery, Consulting Engineers, Inc. (JMM, 1992a);
- IRP Feasibility Studies, JMM and Montgomery Watson (JMM, 1992b; Montgomery Watson, 1993b, 1993c);
- IRP 1993 Site Characterization and Penetrometer System (SCAPS) Investigation discussed in Draft Diesel Spill Area Feasibility Study, Montgomery Watson (Montgomery Watson, 1994).

2.2.3 Old Fire-Fighting Training Facility

The site was reportedly used as a fire-fighting training facility in the 1960s; however, data could not be obtained documenting that fire-fighting activities were conducted. The paved and bermed

area was reported to have been an ice skating rink. Markings on the asphalt indicate that it was also used as a tennis court.

An IRP Remedial Investigation, conducted at the Old Fire-Fighting Training Facility (Harding Lawson Associates [HLA], 1994), included:

- collection and analysis of 50 soil-gas samples
- collection and analysis of soil samples from two soil borings

2.2.4 Nike Missile Fuel Disposal Site A

The Nike Missile Fuel Disposal Area A was used for the disposal of fuel components from Nike Ajax missiles during the mid-1960s.

Investigations conducted at the Nike Missile Fuel Disposal Area A include:

- Reassessment of Sierra Army Depot, Environmental Science and Engineering, Inc. (ESE, 1983)

- IRP Remedial Investigation (HLA, 1994)

A site assessment conducted by ESE at the Nike Missile Fuel Disposal Area A in 1983 documented the physical characteristics and historic disposal practices at the site.

The remedial investigation conducted at the Nike Missile Fuel Disposal Area A (HLA, 1994) included:

- collection and analysis of 94 soil-gas samples

- collection and analysis of 12 soil samples from two soil borings

- installation of two groundwater monitoring wells

- collection of two rounds of groundwater samples from each of the two newly installed monitoring wells

- topographic survey of two control points, two soil borings, and two monitoring wells

2.2.5 Nike Missile Fuel Disposal Site B

The Nike Missile Fuel Disposal Area B was used for the disposal of fuel components from Nike Ajax missiles during the mid-1960s.

Investigations conducted at the Nike Missile Fuel Disposal Area B include:

- Reassessment of Sierra Army Depot (ESE, 1983)
- IRP Remedial Investigation (HLA, 1994)

A site assessment conducted by ESE at the Nike Missile Fuel Disposal Area B in 1983 documented the physical characteristics and historic disposal practices at the site.

The remedial investigation conducted at the Nike Missile Fuel Disposal Area B (HLA, 1994) included:

- an unexploded ordnance survey

- collection and analysis of 100 point soil-gas samples

- collection and analysis of 14 soil samples from two soil borings

- installation of two groundwater monitoring wells

- collection of two rounds of groundwater samples from each of the two newly installed monitoring wells

- topographic survey of two control points, two soil borings, and two monitoring wells

2.2.6 Toxic Storage Building 578

Toxic Storage Building 578 was used at one time to store titanium tetrachloride according to Benioff et al. (1988). ESE (1983) documented the storage of cyanide in the building during a site assessment.

Investigations conducted at the Toxic Storage Building 578 include:

- Reassessment of Sierra Army Depot (ESE, 1983)
- IRP Remedial Investigation (HLA, 1994)

A site assessment conducted by ESE at the Toxic Storage Building 578 in 1983 documented the physical characteristics and reviewed historic storage practices at the site. At the time of the site assessment, the building was being used to store two pallets of glass bottles containing cyanide. Records indicated that one glass bottle containing approximately 1 quart of cyanide had broken on the concrete floor of the building, and that the spill had been cleaned up by the base explosive ordnance disposal personnel.

The remedial investigation conducted at the Toxic Storage Building 578 (HLA, 1994) included:

- collection and analysis of five soil samples from one soil boring
- collection and analysis of three discrete surface soil samples
- attempted installation of one groundwater monitoring well

2.2.7 Unidentified Pit

The Unidentified Pit was observed by the U.S. Army Environmental Hygiene Agency (USAEHA) during a helicopter flight over SIAD in 1989. Located near Honey Lake outside the installation access control fence in the southwest portion of the Main Depot, no record of the pit's prior use exists.

An IRP Remedial Investigation (HLA, 1994), conducted at the Unidentified Pit, included:

- an unexploded ordnance survey
- a surface geophysical survey
- collection and analysis of three discrete surface soil samples
- collection and analysis of three soil samples from two soil borings
- collection and analysis of one groundwater sample from one soil boring

2.3 HIGHLIGHTS OF COMMUNITY PARTICIPATION

The remedial investigation reports for the seven sites were released to the public beginning in October 1991. The feasibility study reports for the TNT Leaching Beds Area and Diesel Spill Area were released to the public beginning in November 1991 and August 1992, respectively. The proposed plan for the seven sites was released to the public in May 1994. These documents were made available to the public in both the Administrative Record file and in information repositories maintained at the following locations:

- Lassen County Free Library, Susanville, CA
- Sierra Army Depot Library, Herlong, CA

The notice of availability for these documents was published in the Reno Gazette Journal on June 7, 1994 and on the Susanville Cable Television Public Announcement Bulletin on June 1, 1994.

One public comment period was held from June 1, 1994 to June 30, 1994. A public meeting was held at Sierra Army Depot on June 7, 1994. Representatives from the Army, DTSC, and RWQCB were present at the meeting. The Responsiveness Summary, Section 3.0 of this ROD/RAP, contains responses to questions from the meeting. No written comments were received by mail during the public comment period.

The public participation requirements of CERCLA §§113(k)(2)(B)(i-v) and 117 and §25356.1 of the California Health and Safety Code were met in the remedy selection. This ROD/RAP presents the selected response actions for the seven sites, at Sierra Army Depot, California, chosen in accordance with CERCLA (as amended by SARA), to the extent practicable, the NCP, and Chapter 6.8 of the California Health and Safety Code. Further, these actions are also being

taken in response to the California Water Code. The basis for this decision is documented in the Administrative Record.

2.4 SCOPE AND ROLE OF RESPONSE ACTION

This ROD/RAP addresses the planned response actions for the seven sites. The purpose of the response actions at the TNT Leaching Beds Area and Diesel Spill Area are to reduce contaminant concentrations in soils at both sites and in groundwater at the Diesel Spill Area, and to implement an evaluation of natural attenuation/degradation to assess whether contaminant migration and degradation rates are within acceptable ranges to the State of California or the Army and initiate institutional controls to prevent adverse exposure to contaminated groundwater at the TNT Leaching Beds Area. A contingency alternative may be implemented for the groundwater at the TNT Leaching Beds Area if the State or the Army determines that natural attenuation and degradation does not adequately protect human health and the environment and comply with ARARs. As discussed in Section 1.3, the remaining five sites discussed in this ROD/RAP require no further action.

2.5 SUMMARY OF SITE CHARACTERISTICS

This section of the ROD/RAP provides an overview of the nature and extent of contamination at the seven sites.

2.5.1 Paint Shop Subsite

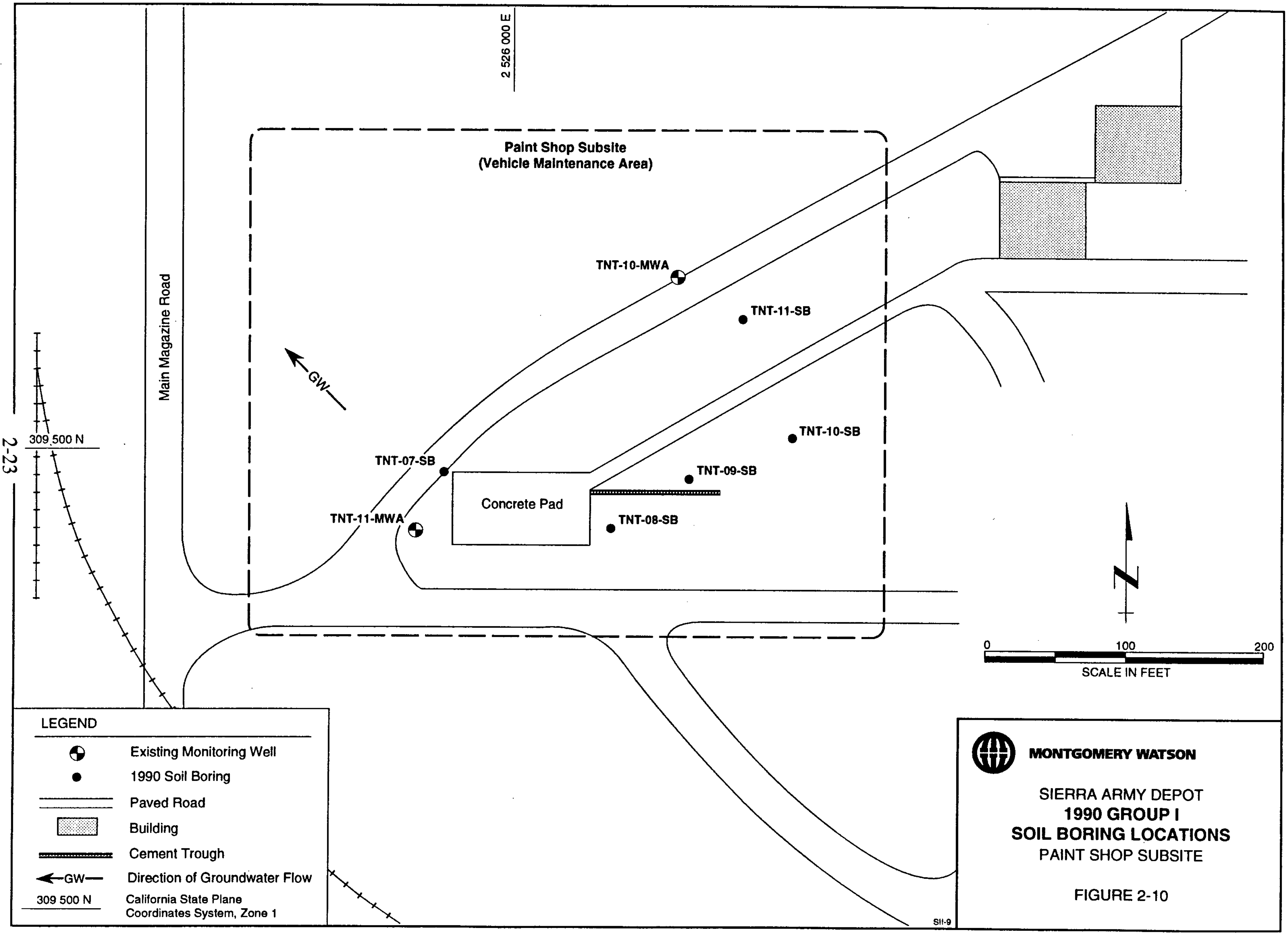
2.5.1.1 Soil. The distribution and extent of soil contamination at the Paint Shop Subsite was assessed based on investigations conducted during the 1990 Group I RI and 1992 Group I Follow-Up RI.

<u>1990 Group I RI</u>

The focus of the 1990 Group I RI conducted by JMM and E.C. Jordan (1991b) was to determine a source for the TCE previously detected in the groundwater beneath the site. The investigation included a soil-gas survey, and the drilling and sampling of soil borings.

The results of the soil-gas survey outlined an area of elevated soil-gas VOC concentrations near the Paint Shop Subsite. The VOCs detected were total hydrocarbons (THC), chloroform, carbon tetrachloride, and TCE. TCE was the most widely distributed soil-gas contaminant at the site. The highest soil-gas concentrations generally occurred north of the former paint shop. This implies that the former paint shop is the VOC source in the area.

Based on the soil-gas results, five soil borings were drilled and sampled to the groundwater table (Figure 2-10). Samples were analyzed for priority pollutant metals, VOCs, and explosives. TCE was not detected in any of the samples collected. Toluene was the only VOC detected in soil. Three explosive compounds were detected at low levels in the 35-foot interval from the



MONTGOMERY WATSON

SIERRA ARMY DEPOT
1990 GROUP I
SOIL BORING LOCATIONS
PAINT SHOP SUBSITE

FIGURE 2-10

paint shop. No other compounds were detected in the soil at this subsite during the 1990 Group I RI.

1992 Group I Follow-Up RI

Activities for the 1992 Group I Follow-Up RI included soil-gas and geophysical surveys, shallow soil borings with the use of a mobile laboratory for soil sample screening, and two soil borings.

The soil-gas survey was conducted to supplement the results of the 1990 Group I RI (Figure 2-11). This soil-gas survey concentrated on the area to the east of the concrete slab, which includes the concrete trough. High levels of VOCs were detected in the soil-gas at the end of the concrete trough.

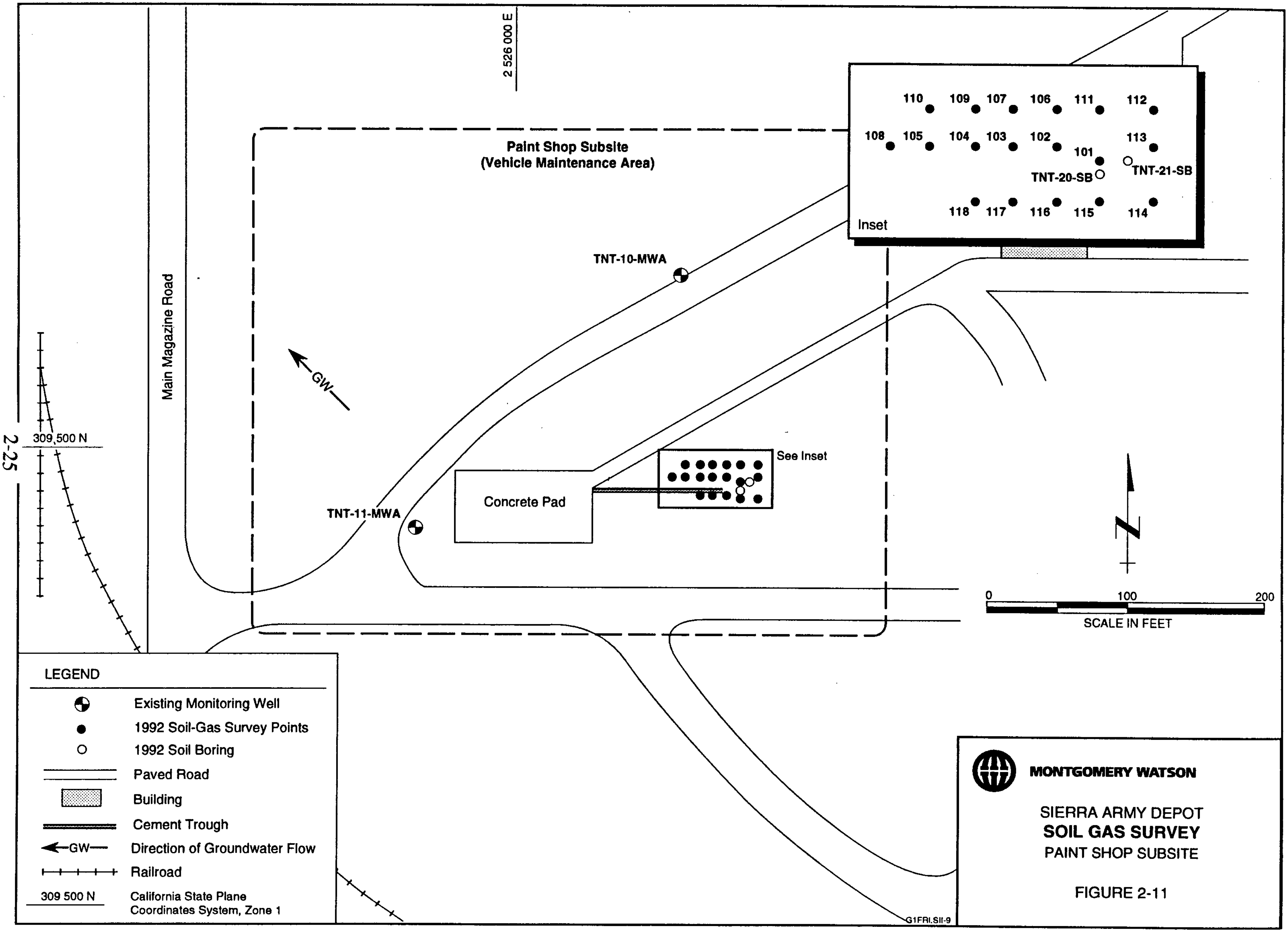
The area to the east of the concrete pad along the concrete trough was further investigated by drilling shallow soil borings with a drill rig and a hand auger; samples were analyzed on site with a mobile laboratory. The results of this sampling effort yielded high levels of SVOCs and lesser amounts of VOCs in the 0- to 5-foot interval at the end of the concrete trough (Figure 2-12). Total SVOCs in the 5-foot interval exceeded 5,000 mg/kg. The data obtained from the shallow soil borings were used to locate soil boring TNT-21-SB.

The geophysical survey focused on the area around the concrete trough. A magnetic anomaly identified as metal pipe was found beneath the trough. This magnetic anomaly terminated at the end of the concrete trough in a disturbed area containing native soil mixed with large concrete blocks. High levels of VOCs and SVOCs were detected in soil-gas samples and hand-auger samples collected from the disturbed area. It is interpreted that this disturbed area received wastewater containing solvents from the paint shop sink and floor drains from the 1940s until the mid-1950s. The effluent flowed down the concrete trough and/or through pipes beneath it and into a drywell or settling pond.

Two surface-soil samples were collected from soil borings drilled and sampled to the water table near the end of the concrete trough. Samples were analyzed for SVOCs and VOCs. SVOCs were detected in one of two surface-soil samples collected in the area at the end of the concrete trough; 10 SVOCs were detected in the surface interval of soil boring TNT-21-SB (Figure 2-13). Toluene was detected at a very low concentration of 0.002 mg/kg in the surface interval of soil boring TNT-21-SB.

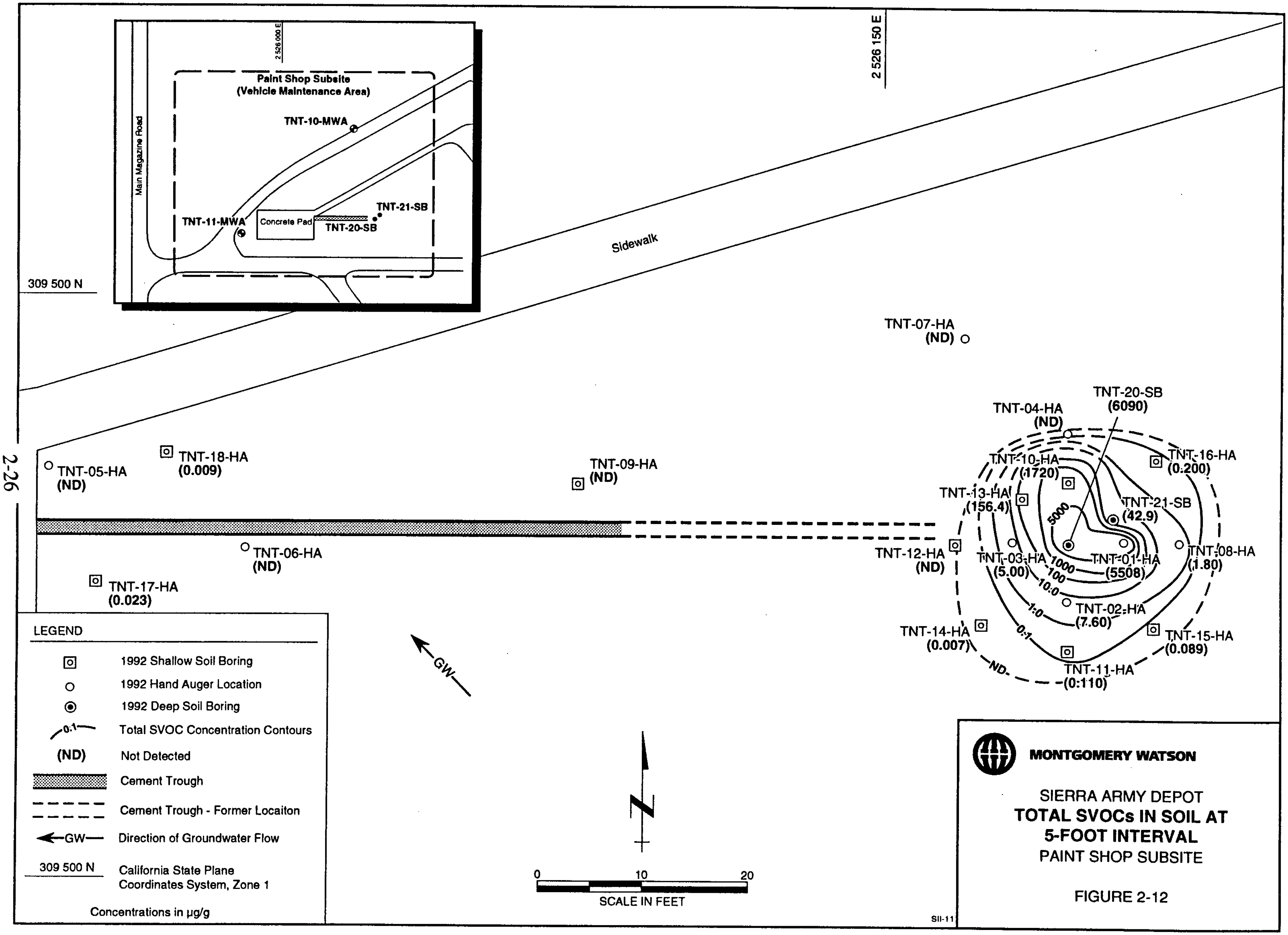
The two soil borings were drilled to the water table (approximately 65 feet bgs), and sampled at 5-foot intervals to the water table and analyzed for metals, SVOCs, and VOCs. Metals were not detected at levels exceeding background levels in the subsurface soil samples. SVOCs were detected in six of 14 subsurface soil samples (Figure 2-14). SVOCs detected include 2-chlorophenol, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, and 2-methylnaphthalene.

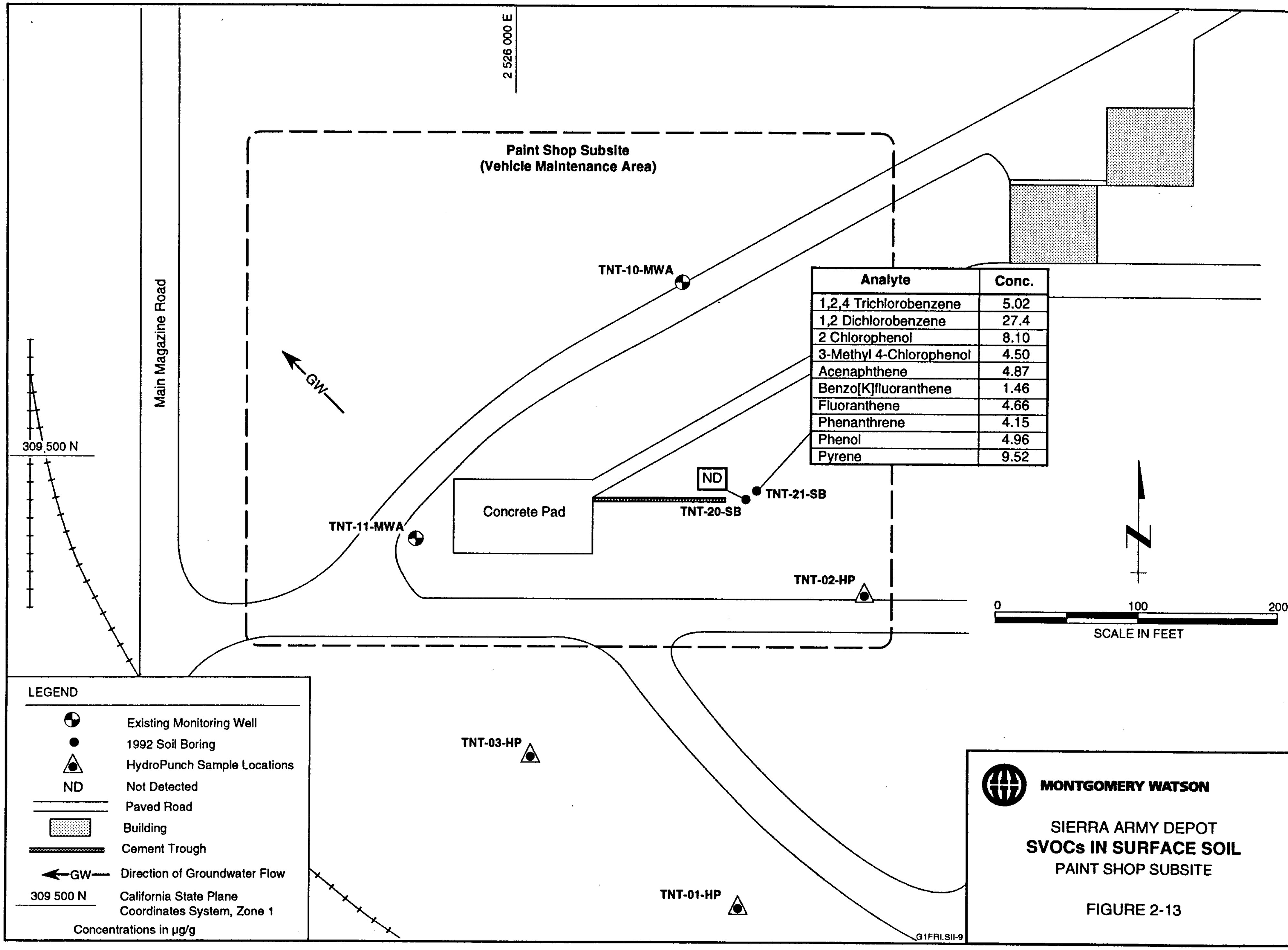
1,2-Dichlorobenzene was detected in two subsurface samples collected from TNT-21-SB and in three subsurface soil samples from TNT-20-SB. The maximum 1,2-dichlorobenzene concen-



SIERRA ARMY DEPOT
SOIL GAS SURVEY
PAINT SHOP SUBSITE

FIGURE 2-11


Paint Shop Subsite
(Vehicle Maintenance Area)
Main Magazine Road
2 526 000 E
TNT-10-MWA
TNT-11-MWA
Concrete Pad
TNT-21-SB
TNT-20-SB
309 500 N
2 526 150 E
Sidewalk
TNT-07-HA (ND)
TNT-20-SB (6090)
TNT-04-HA (ND)
TNT-16-HA (0.200)
TNT-10-HA (1720)
TNT-13-HA (156.4)
TNT-21-SB (42.9)
TNT-12-HA (ND)
TNT-03-HA (5.00)
TNT-01-HA (5508)
TNT-08-HA (1.80)
TNT-02-HA (7.60)
TNT-14-HA (0.007)
TNT-15-HA (0.089)
TNT-11-HA (0.110)
5000
1000
100
10.0
1.0
0.1
ND
TNT-05-HA (ND)
TNT-18-HA (0.009)
TNT-09-HA (ND)
TNT-06-HA (ND)
TNT-17-HA (0.023)
GW
LEGEND
1992 Shallow Soil Boring
1992 Hand Auger Location
1992 Deep Soil Boring
0.1 Total SVOC Concentration Contours
(ND) Not Detected
Cement Trough
Cement Trough - Former Locaiton
GW Direction of Groundwater Flow
309 500 N California State Plane Coordinates System, Zone 1
Concentrations in µg/g
0 10 20
SCALE IN FEET
SII-11
MONTGOMERY WATSON
SIERRA ARMY DEPOT
TOTAL SVOCs IN SOIL AT
5-FOOT INTERVAL
PAINT SHOP SUBSITE
FIGURE 2-12



Analyte	Conc.
1,2,4 Trichlorobenzene	5.02
1,2 Dichlorobenzene	27.4
2 Chlorophenol	8.10
3-Methyl 4-Chlorophenol	4.50
Acenaphthene	4.87
Benzo[K]fluoranthene	1.46
Fluoranthene	4.66
Phenanthrene	4.15
Phenol	4.96
Pyrene	9.52

SIERRA ARMY DEPOT
SVOCs IN SURFACE SOIL
PAINT SHOP SUBSITE

FIGURE 2-13

tration detected was 27.8 mg/kg in the 8.5-foot interval of TNT-21-SB. 1,3-Dichlorobenzene and 1,4-dichlorobenzene were detected at concentrations of 144 mg/kg and 5,880 mg/kg, respectively, in the sample collected from the 5-foot interval in TNT-20-SB. However, 1,4-dichlorobenzene was not detected in samples collected from depths below 5 feet. Other SVOCs detected in subsurface soils at the Paint Shop Subsite are presented on Figure 2-14. No SVOCs were detected in proximity to the water table.

VOCs were detected in five of 27 samples collected from the subsurface at the Paint Shop Subsite during the 1992 Group I Follow-Up RI (Figure 2-15). The compounds detected were ethylbenzene (0.0021 mg/kg), toluene (0.002 mg/kg), tetrachloroethene (0.002 mg/kg to 0.008 mg/kg), xylenes (0.022 mg/kg to 0.11 mg/kg), and chloroform (0.001 mg/kg). Very low levels of chloroform were detected at the soil/groundwater interface (63.5 feet bgs) in soil boring TNT-21-SB.

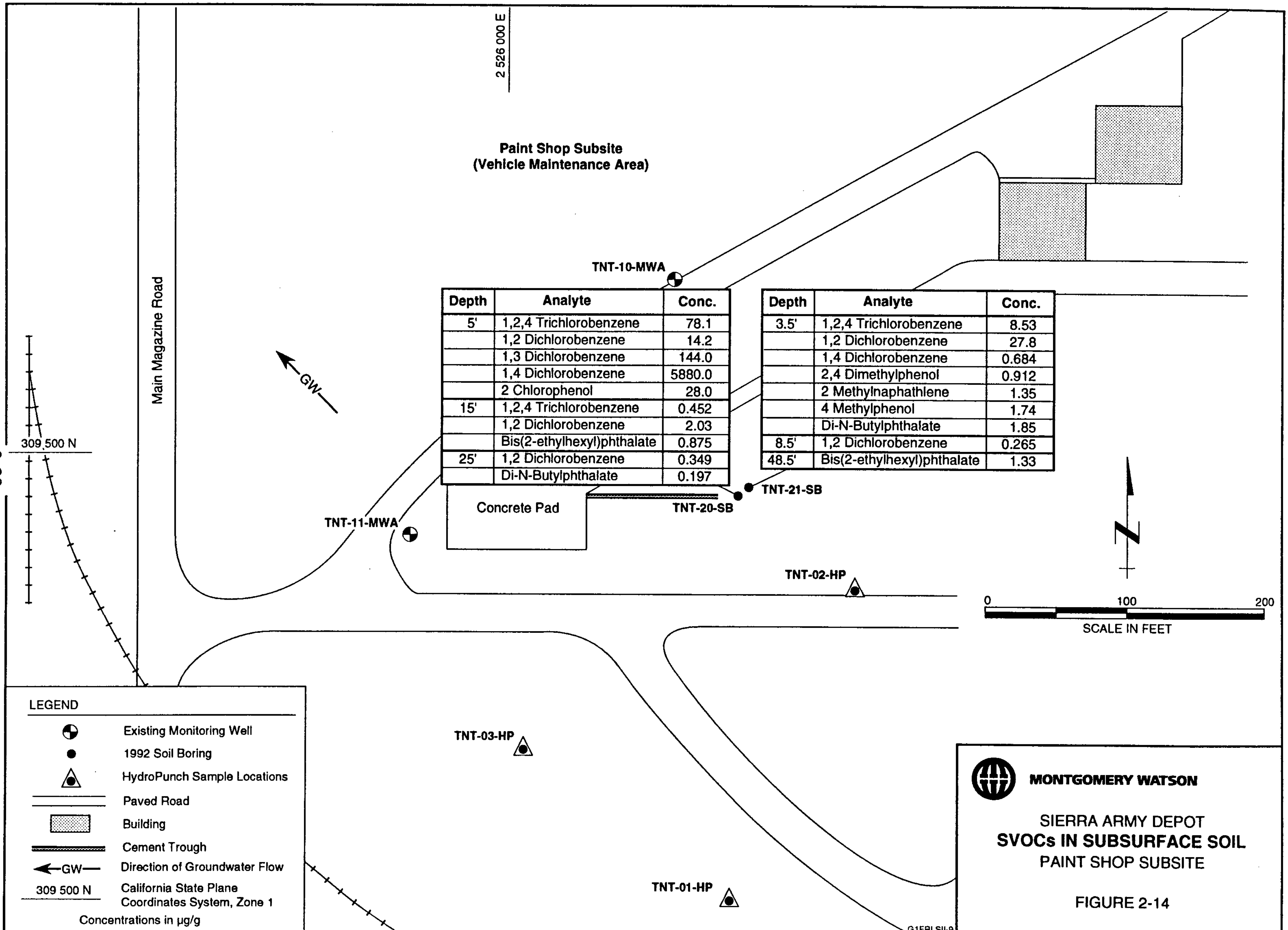
2.5.1.2 Groundwater. Groundwater at the Paint Shop Subsite was investigated by USAEHA in 1986 and 1988, and by Montgomery Watson (formerly JMM) as part of the 1990 Group I RI, 1991 Group II RI, and 1992 Group I Follow-Up RI.

The following discussion on the nature and extent of groundwater contamination at the Paint Shop Subsite focuses on data collected from six rounds of sampling conducted over a 3-year period (1990 through 1992) on six "A" zone monitoring wells, one "B" zone monitoring well, and one "C" zone monitoring well and from data collected over a 2-year period (1991 through 1992) on one "A" zone monitoring well. The wells sampled are listed below:

- TNT-08-MWA
- TNT-09-MWA
- TNT-10-MWA
- TNT-10-MWB
- TNT-10-MWC
- TNT-11-MWA
- TNT-12-MWA
- TNT-13-MWA
- DSA-02-MWA

These monitoring wells were selected to evaluate the groundwater at the Paint Shop Subsite because of their proximity to the concrete pad and trough. The "A" zone refers to placing the screened interval in the monitoring well in the upper 15 feet of the saturated zone so that it straddles the water table. The "B" and "C" zones refer to screen placement approximately 40 and 80 feet below the "A" zone in each well cluster.

Samples collected during the 1990 Group I RI and 1991 Group II RI were analyzed for priority pollutant metals, SVOCs, pesticides/PCBs, explosive compounds, and VOCs; additionally, Group II RI samples were analyzed for cyanide. Samples collected during the 1990 Group I Follow-Up investigation were analyzed for priority pollutant metals plus barium and VOCs; TNT-08-MWA was also analyzed for explosive compounds. Samples collected from

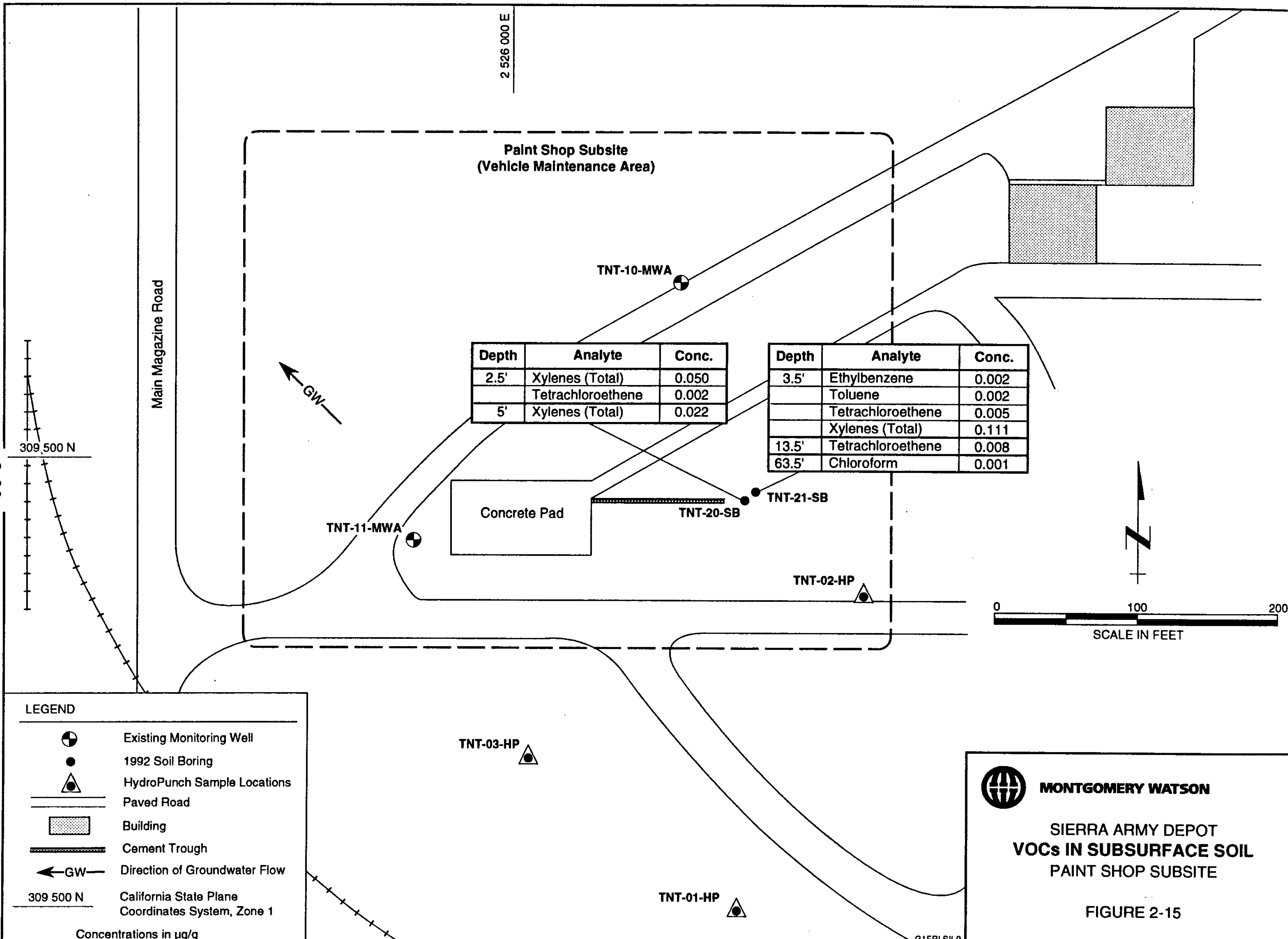


Depth	Analyte	Conc.
5'	1,2,4 Trichlorobenzene	78.1
	1,2 Dichlorobenzene	14.2
	1,3 Dichlorobenzene	144.0
	1,4 Dichlorobenzene	5880.0
	2 Chlorophenol	28.0
15'	1,2,4 Trichlorobenzene	0.452
	1,2 Dichlorobenzene	2.03
	Bis(2-ethylhexyl)phthalate	0.875
25'	1,2 Dichlorobenzene	0.349
	Di-N-Butylphthalate	0.197

Depth	Analyte	Conc.
3.5'	1,2,4 Trichlorobenzene	8.53
	1,2 Dichlorobenzene	27.8
	1,4 Dichlorobenzene	0.684
	2,4 Dimethylphenol	0.912
	2 Methylnaphathlene	1.35
	4 Methylphenol	1.74
	Di-N-Butylphthalate	1.85
8.5'	1,2 Dichlorobenzene	0.265
48.5'	Bis(2-ethylhexyl)phthalate	1.33

SIERRA ARMY DEPOT
SVOCs IN SUBSURFACE SOIL
PAINT SHOP SUBSITE

FIGURE 2-14



Depth	Analyte	Conc.
2.5'	Xylenes (Total)	0.050
	Tetrachloroethene	0.002
5'	Xylenes (Total)	0.022

Depth	Analyte	Conc.
3.5'	Ethylbenzene	0.002
	Toluene	0.002
	Tetrachloroethene	0.005
	Xylenes (Total)	0.111
13.5'	Tetrachloroethene	0.008
63.5'	Chloroform	0.001

MONTGOMERY WATSON

SIERRA ARMY DEPOT
VOCs IN SUBSURFACE SOIL
PAINT SHOP SUBSITE

FIGURE 2-15

DSA-02-MWA were analyzed for total petroleum hydrocarbons as diesel (TPH-diesel), SVOCs, and VOCs. The data from the monitoring well samples were supplemented by the collection of three HydroPunch samples during the 1992 Group I Follow-Up investigation. HydroPunch samples were analyzed for VOCs and explosive compounds. A summary of organic and explosive compounds detected in groundwater at the Paint Shop Subsite is presented in Table 2-1.

Several metals were detected in the "A" zone monitoring wells at the Paint Shop Subsite during the three years of groundwater monitoring but only chromium and lead were detected at concentrations above background levels. Chromium has not been detected in background water samples; the certified reporting limit (CRL) for chromium is 6.02 micrograms per liter (μg/l). Lead has been detected in background groundwater samples at a maximum concentration of 1.84 μg/l. Chromium was detected in TNT-10-MWA at levels above background and the California maximum contaminant level (MCL) of 50 μg/l in all six rounds of sampling. The highest chromium concentration detected was 225 μg/l during the first round of sampling in 1990. Levels of chromium in this well were observed to decrease in each of the five subsequent sampling rounds; the chromium concentration detected in the sample collected during the last round in 1992 was 177 μg/l. Chromium was not detected in TNT-10-MWB and TNT-10-MWC. Lead was detected above the background level in six of seven "A" zone monitoring wells and in "C" zone monitoring well, TNT-10-MWC. Detections of lead in all wells were intermittent with lead detections occurring in two of six rounds on five "A" zone wells and in one of four sampling rounds in a sixth. Lead was also detected in TNT-10-MWC in one of six rounds (2.93 μg/l in the second round during 1990). None of the detected lead levels at the Paint Shop Subsite exceed the federal action level of 15 μg/l.

Arsenic, barium, selenium, mercury, and zinc were also detected in one or more "A" zone wells. Mercury was detected slightly above background at a concentration of 0.26 μg/l in TNT-10-MWA in one of six sampling rounds (April 1990). Mercury has not been detected in background groundwater samples; the CRL for mercury is 0.243 μg/l. Arsenic, barium, selenium, and zinc were all detected at levels below background levels and California MCLs. The maximum concentrations of arsenic, barium, selenium, and zinc detected in background groundwater samples are 290 μg/l, 28.9 μg/l, 10.2 μg/l, and 117 μg/l, respectively.

Cyanide was detected in TNT-10-MWA in both samples collected during the 1991 Group II investigation; detected concentrations were 150 μg/l (April 1991) and 210 μg/l (July 1991). One of these samples is slightly above the proposed federal MCL of 200 μg/l. There is no California MCL for cyanide.

Groundwater samples collected from DSA-02-MWA were analyzed for TPH-diesel since this well was installed as a downgradient well for the Diesel Spill Area. TPH-diesel was not detected in any of the four rounds of sampling conducted on this well.

Bis(2-ethylhexyl)phthalate was the only SVOC detected in any of the Paint Shop Subsite monitoring wells. This compound was detected in one of four sampling rounds in monitoring well, DSA-02-MWA (March 1992) and is interpreted to be a result of laboratory contamination.

TABLE 2-1

ORGANIC AND EXPLOSIVE COMPOUNDS IN GROUNDWATER
TNT LEACHING BEDS AREA MONITORING WELLS
(Page 1 of 7)

Monitoring Well	Concentration (µg/l)					
	Round 1 Apr-90	Round 2 Jun-90	Round 3 Apr-91	Round 4 Jul-91	Round 5 Mar-92	Round 6 May-92
TNT-01-MWA						
VOCs						
TCE	26.7	30.5	23.8	30.5	25.7	24.8
Chloroform	ND	ND	ND	0.523	ND	2.05
Explosive Compounds						
1,3,5-TNB	1100	1100	1500	1100	1000	1000
2,4,6-TNT	1.05	1.22	1.26	ND	4.51	5.16
2,4-DNT	90	86	ND	2.74	ND	ND
HMX	3.7	ND	ND	ND	ND	ND
RDX	99	87	140	92	85.1	97
Tetryl	9.92	ND	ND	13.6	ND	ND
TNT-01-MWB						
VOCs						
	ND	ND	NA	NA	ND	ND
Explosive Compounds						
	ND	ND	NA	NA	ND	ND
TNT-01-MWC						
VOCs						
TCE	ND	2	ND	ND	ND	ND
Chloroform	ND	1.13	ND	ND	ND	ND
Explosive Compounds						
1,3,5-TNB	0.793	ND	ND	ND	ND	1.02
RDX	ND	4.18	4	ND	ND	ND

TABLE 2-1

ORGANIC AND EXPLOSIVE COMPOUNDS IN GROUNDWATER
TNT LEACHING BEDS AREA MONITORING WELLS
(Page 2 of 7)

Monitoring Well	Concentration (µg/l)					
	Round 1 Apr-90	Round 2 Jun-90	Round 3 Apr-91	Round 4 Jul-91	Round 5 Mar-92	Round 6 May-92
TNT-02-MWA						
VOCs						
TCE	3.52	2.57	ND	ND	ND	ND
Explosive Compounds						
1,3,5-TNB	230	220	220	130	100	120
2,4,6-TNT	7.86	8.14	5.87	5.72	5.69	7.15
2,4-DNT	6.92	5.93	4.66	1.82	0.258	1.36
2,6-DNT	ND	ND	ND	ND	1.35	3.41
Nitrobenzene	ND	ND	ND	4.38	ND	4.66
HMX	3.76	ND	4.08	ND	15	ND
RDX	250	220	130	98	45.8	88.3
Tetryl	ND	ND	ND	15.5	ND	ND
TNT-02-MWB						
Explosive Compounds						
1,3,5-TNB	ND	1.38	NA	NA	ND	ND
Tetryl	ND	0.754	NA	NA	ND	ND
TNT-02-MWC						
Explosive Compounds						
Tetryl	ND	0.813	NA	NA	NA	NA
TNT-03-MWA						
Explosive Compounds						
1,3,5-TNB	9.96	13	10.4	9.03	2.52	2.81
2,4,6-TNT	2.94	6.19	ND	ND	2.39	ND
2,4-DNT	12.6	ND	5.15	3.09	3.82	0.706
2,6-DNT	ND	ND	ND	ND	ND	1.09
HMX	7.69	ND	4.14	ND	ND	ND
RDX	220	34.2	ND	12.1	140	25.6

TABLE 2-1

ORGANIC AND EXPLOSIVE COMPOUNDS IN GROUNDWATER
TNT LEACHING BEDS AREA MONITORING WELLS
(Page 3 of 7)

Monitoring Well	Concentration (µg/l) Round 1 Apr-90	Round 2 Jun-90	Round 3 Apr-91	Round 4 Jul-91	Round 5 Mar-92	Round 6 May-92
TNT-04-MWA						
Explosive Compounds						
1,3,5-TNB	2.99	3.38	NA	NA	2.12	2.35
2,4,6-TNT	1.24	1.03	NA	NA	3.08	3.15
2,4-DNT	8.14	10.3	NA	NA	0.78	1.57
2,6-DNT	ND	ND	NA	NA	1.7	2.18
Nitrobenzene	ND	ND	NA	NA	3.5	2.44
TNT-05-MWA						
Explosive Compounds						
1,3,5-TNB	5.28	6.47	NA	NA	NA	NA
TNT-06-MWA						
Explosive Compounds						
1,3,5-TNB	1.65	2.34	NA	NA	ND	2.36
2,4,6-TNT	ND	ND	NA	NA	ND	2.16
2,4-DNT	ND	0.85	NA	NA	0.65	0.388
2,6-DNT	ND	ND	NA	NA	0.65	0.451
TNT-07-MWA						
VOCs						
TCE	2.29	2.48	NA	NA	1.14	2.1
Chloroform	ND	0.523	NA	NA	ND	ND
Explosive Compounds						
1,3,5-TNB	5.59	4.98	NA	NA	0.983	3.53
2,4-DNT	2.04	2.56	NA	NA	0.364	0.81
2,6-DNT	ND	ND	NA	NA	0.0919	ND
Tetryl	2.79	ND	NA	NA	ND	ND

TABLE 2-1

ORGANIC AND EXPLOSIVE COMPOUNDS IN GROUNDWATER
TNT LEACHING BEDS AREA MONITORING WELLS
(Page 4 of 7)

Monitoring Well	Concentration (µg/l)					
	Round 1 Apr-90	**Round 2 Jun-90**	**Round 3 Apr-91**	**Round 4 Jul-91**	**Round 5 Mar-92**	**Round 6 May-92**
TNT-07-MWB						
VOCs						
TCE	ND	ND	NA	NA	1.33	ND
Explosive Compounds	ND	ND	NA	NA	NA	NA
TNT-07-MWC						
VOCs	ND	ND	NA	NA	NA	NA
Explosive Compounds	ND	ND	NA	NA	NA	NA
TNT-08-MWA						
VOCs						
TCE	7.43	9.33	NA	NA	14.3	13.3
Explosive Compounds						
1,3,5-TNB	0.892	0.885	NA	NA	0.647	ND
2,4-DNT	ND	ND	NA	NA	0.236	0.272
RDX	ND	ND	NA	NA	1.59	1.83
Tetryl	1.56	ND	NA	NA	ND	ND
TNT-09-MWA						
VOCs						
TCE	0.924	1.05	1.33	0.81	NA	NA
Explosive Compounds						
1,3,5-TNB	1.47	3.81	1.71	1.87	NA	NA
1,3-DNB	ND	ND	1.72	ND	NA	NA
HMX	ND	ND	5.24	ND	NA	NA

TABLE 2-1

ORGANIC AND EXPLOSIVE COMPOUNDS IN GROUNDWATER
TNT LEACHING BEDS AREA MONITORING WELLS
(Page 5 of 7)

Monitoring Well	Concentration (µg/l) Round 1 Apr-90	Round 2 Jun-90	Round 3 Apr-91	Round 4 Jul-91	Round 5 Mar-92	Round 6 May-92
TNT-10-MWA						
VOCs						
TCE	952	571	952	857	1,000	1,000
1,2-Dichloroethane	101	50.3	101	80.4	90.5	80.4
Carbon Tetrachloride	190	95.2	190	190	190	95.2
Chloroform	923	513	718	615	718	513
TNT-10-MWB						
VOCs						
TCE	0.724	0.838	NA	NA	0.505	1.05
TNT-10-MWC						
VOCs						
TCE	2	ND	ND	ND	ND	ND
Explosive Compounds						
RDX	ND	ND	6.27	ND	NA	NA
TNT-11-MWA						
VOCs						
TCE	114	190	181	210	175	181
1,2-Dichloroethane	0.824	ND	0.874	1.21	ND	ND
Carbon Tetrachloride	11.4	19	19	17.1	17.8	12.4
Chloroform	21.5	41	26.7	32.8	27.3	27.7
Explosive Compounds						
1,3,5-TNB	ND	0.867	1.02	0.824	NA	NA

TABLE 2-1

**ORGANIC AND EXPLOSIVE COMPOUNDS IN GROUNDWATER
TNT LEACHING BEDS AREA MONITORING WELLS
(Page 6 of 7)**

Monitoring Well	Concentration (µg/l)					
	Round 1 Apr-90	Round 2 Jun-90	Round 3 Apr-91	Round 4 Jul-91	Round 5 Mar-92	Round 6 May-92
TNT-12-MWA						
VOCs						
TCE	1.05	0.819	NA	NA	1.43	1.43
Chloroform	ND	0.749	NA	NA	1.13	1.13
Explosive Compounds						
1,3,5-TNB	1.12	ND	NA	NA	NA	NA
2,4-DNT	0.769	ND	NA	NA	NA	NA
TNT-13-MWA						
VOCs						
TCE	8.57	9.52	9.52	10.5	8.83	10.5
Chloroform	ND	0.533	0.749	0.554	0.714	0.841
Explosive Compounds						
1,3,5-TNB	ND	ND	1.7	1.69	NA	NA
TNT-14-MWA						
VOCs						
TCE	ND	ND	NA	NA	NA	NA
Chloroform	ND	ND	NA	NA	NA	NA
Explosive Compounds						
1,3,5-TNB	11.9	13.5	NA	NA	NA	NA
TNT-15-MWA						
VOCs						
TCE	ND	ND	NA	NA	NA	NA
Chloroform	ND	ND	NA	NA	NA	NA

ORGANIC AND EXPLOSIVE COMPOUNDS IN GROUNDWATER
TNT LEACHING BEDS AREA MONITORING WELLS
(Page 7 of 7)

Monitoring Well	Concentration (µg/l)					
	Round 1 Apr-90	**Round 2 Jun-90**	**Round 3 Apr-91**	**Round 4 Jul-91**	**Round 5 Mar-92**	**Round 6 May-92**
Explosive Compounds						
Tetryl	1.1	ND	NA	NA	NA	NA
RDX	ND	6.7	NA	NA	NA	NA
TNT-16-MWA						
VOCs						
TCE	ND	ND	ND	ND	NA	NA
Chloroform	ND	ND	ND	ND	NA	NA
Explosive Compounds						
1,3,5-TNB	ND	ND	ND	ND	NA	NA
DF-01-MWA						
VOCs						
TCE	NA	NA	ND	ND	ND	ND
Chloroform	NA	NA	ND	ND	ND	ND
DSA-02-MWA						
VOCs						
TCE	NA	NA	53.3	21.9	17.5	16.2
Carbon Tetrachloride	NA	NA	22.9	4.25	2.97	2.1
Chloroform	NA	NA	13.3	3.38	2.63	2.36

NA - not analyzed
ND - not detected

Explosive compounds were detected intermittently in six monitoring wells over the 3-year monitoring period and in one HydroPunch sample collected during the 1992 Group I Follow-Up investigation. Compounds detected, concentrations, and sampling rounds in which they were detected are presented in Table 2-1.

VOCs were detected in all seven "A" zone monitoring wells in the vicinity of the Paint Shop Subsite. These compounds were also detected in two of three HydroPunch samples. The VOCs detected are TCE, 1,2-dichloroethane, carbon tetrachloride, and chloroform (Table 2-1).

TCE was detected in all of the "A" zone monitoring wells at levels ranging from 0.81 μg/l to 952 μg/l and in HydroPunch samples TNT-02-HP (49.9 μg/l) and TNT-03-HP (2.02 μg/l). This TCE groundwater contamination is part of a bilobate plume that extends eastward toward the TNT Leaching Beds Subsite (Figure 2-16). It is interpreted from the shape of the plume and the detected concentrations of TCE that the bilobate plume originates from two sources: the end of the concrete trough at the Paint Shop Subsite and the TNT leaching beds.

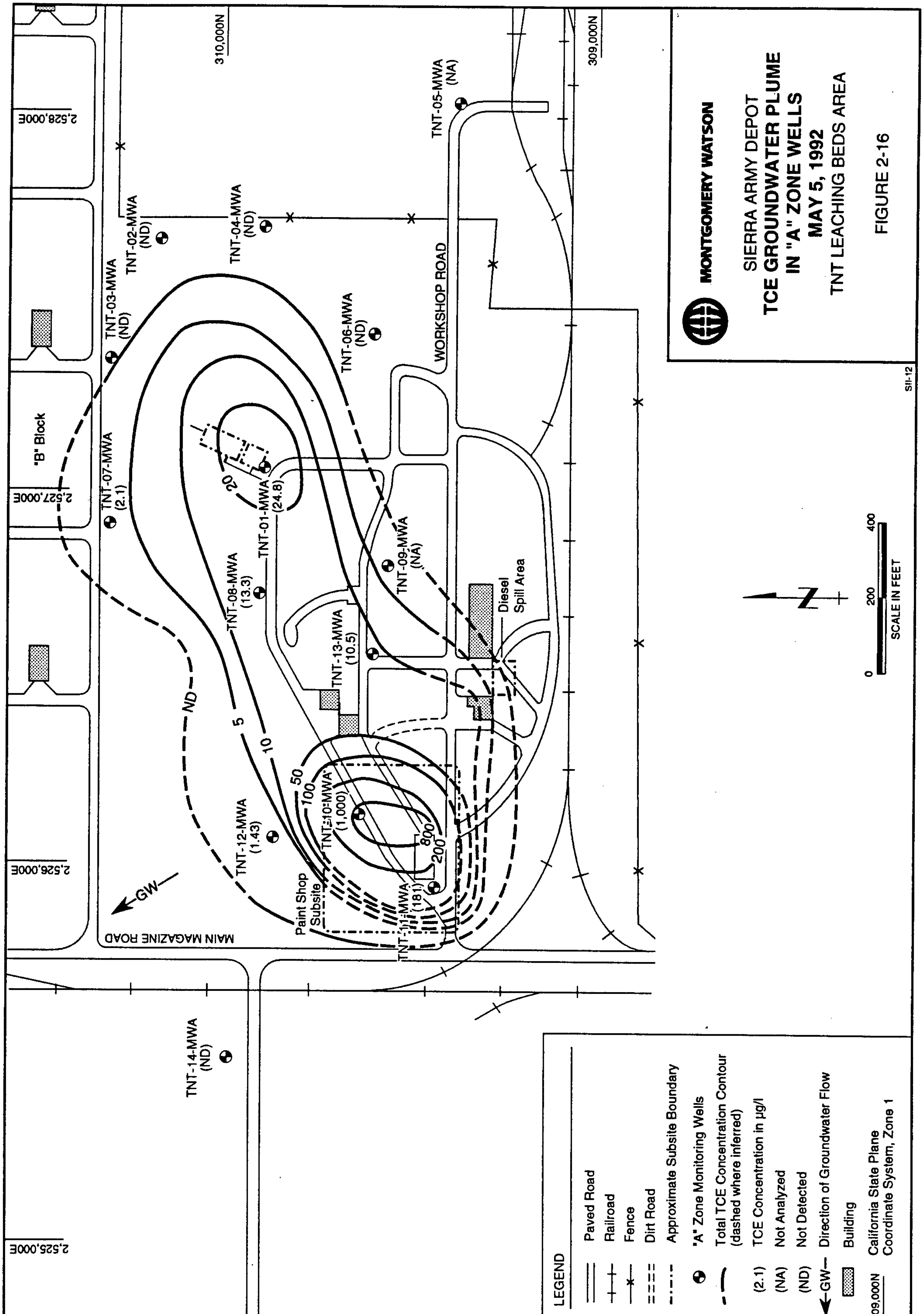
Chloroform was detected in all of the "A" zone monitoring wells at the Paint Shop Subsite except TNT-08-MWA and TNT-09-MWA. These two monitoring wells are located furthest east from the paint shop.

Carbon tetrachloride and 1,2-dichloroethane were detected in two "A" zone monitoring wells at the site: TNT-10-MWA and TNT-11-MWA (Table 2-1). TNT-10-MWA is located directly downgradient from the suspected source at the end of the concrete trough and contains the highest detected levels of VOCs in the area. TNT-11-MWA is located immediately west of the concrete slab foundation of the old paint shop building.

TCE was detected at low levels in intermediate cluster well TNT-10-MWB, during all four rounds of sampling (1990 and 1992) (Table 2-1). TCE concentrations ranged from 0.51 μg/l to 1.1 μg/l. It is evident from these data that there is little hydraulic connection between the "A" and "B" zones at this location since the concentration in the "A" zone immediately above TNT-10-MWB is 1,000 times that in the "B" zone. However, vertical flow potential exists based upon vertical hydraulic gradient data. TCE was detected in the first of six rounds of sampling in TNT-10-MWC at a concentration of 2 μg/l. TCE has not been detected in the subsequent five rounds of sampling, indicating there is little hydraulic connection between the "A" and "C" zones. The fact that there is little to no TCE in the "B" and "C" zone wells indicates that TCE is restricted to the upper zones of the aquifer.

2.5.1.3 Paint Shop Subsite Summary. A soil-gas survey conducted during the 1990 Group I RI (JMM and E.C. Jordan, 1991b) indicated the presence of a soil-gas TCE plume centered on the eastern side of the former paint shop concrete slab foundation. Soil-gas TCE values in this area were higher by at least one order of magnitude than any other location within a radius of 400 feet.

A geophysical survey conducted in the area east of the concrete slab indicated the presence of buried pipes underneath a concrete trough leading to a disturbed area approximately 100 feet east


MONTGOMERY WATSON
SIERRA ARMY DEPOT
TCE GROUNDWATER PLUME
IN "A" ZONE WELLS
MAY 5, 1992
TNT LEACHING BEDS AREA
FIGURE 2-16
SII-12
2,528,000E
2,527,000E
2,526,000E
2,525,000E
310,000N
309,000N
"B" Block
TNT-01-MWA (24.8)
TNT-02-MWA (ND)
TNT-03-MWA (ND)
TNT-04-MWA (ND)
TNT-05-MWA (NA)
TNT-06-MWA (ND)
TNT-07-MWA (2.1)
TNT-08-MWA (13.3)
TNT-09-MWA (NA)
TNT-10-MWA (1,000)
TNT-11-MWA (181)
TNT-12-MWA (1.43)
TNT-13-MWA (10.5)
TNT-14-MWA (ND)
WORKSHOP ROAD
MAIN MAGAZINE ROAD
Diesel Spill Area
Paint Shop Subsite
GW
ND
5
10
20
50
100
200
800
N
0
200
400
SCALE IN FEET
LEGEND
Paved Road
Railroad
Fence
Dirt Road
Approximate Subsite Boundary
"A" Zone Monitoring Wells
Total TCE Concentration Contour (dashed where inferred)
(2.1) TCE Concentration in µg/l
(NA) Not Analyzed
(ND) Not Detected
GW Direction of Groundwater Flow
Building
309,000N California State Plane Coordinate System, Zone 1

of the concrete slab foundation. The disturbed area was approximately 6 feet in diameter and appeared to be a pit filled with blocks of concrete and native sand.

Soil samples collected from shallow soil borings and analyzed for VOCs and SVOCs in a mobile laboratory indicated high levels of SVOCs within a 10-foot diameter surrounding the disturbed area. SVOCs and VOCs were detected in two soil borings drilled near the center of the disturbed area. Detected concentrations of SVOCs were much higher than those detected for VOCs; however, low levels of VOCs were detected at the soil/groundwater interface, indicating that VOCs have migrated to the water table at this site. It is interpreted that this disturbed area received wastewater containing solvents from the paint shop sink and floor drains from the 1940s until the mid-1950s. The effluent flowed down the concrete trough and/or through pipes beneath it and into a drywell or settling pond.

High levels of VOCs (TCE, carbon tetrachloride, 1,2-dichloroethane, and chloroform) have been detected in groundwater beneath the Paint Shop Subsite. The highest levels of VOCs are directly downgradient from the paint shop. Results from HydroPunch samples collected south and upgradient of the paint shop confirms that a source of VOCs does not exist to the south of the Paint Shop Subsite.

2.5.2 TNT Leaching Beds Subsite

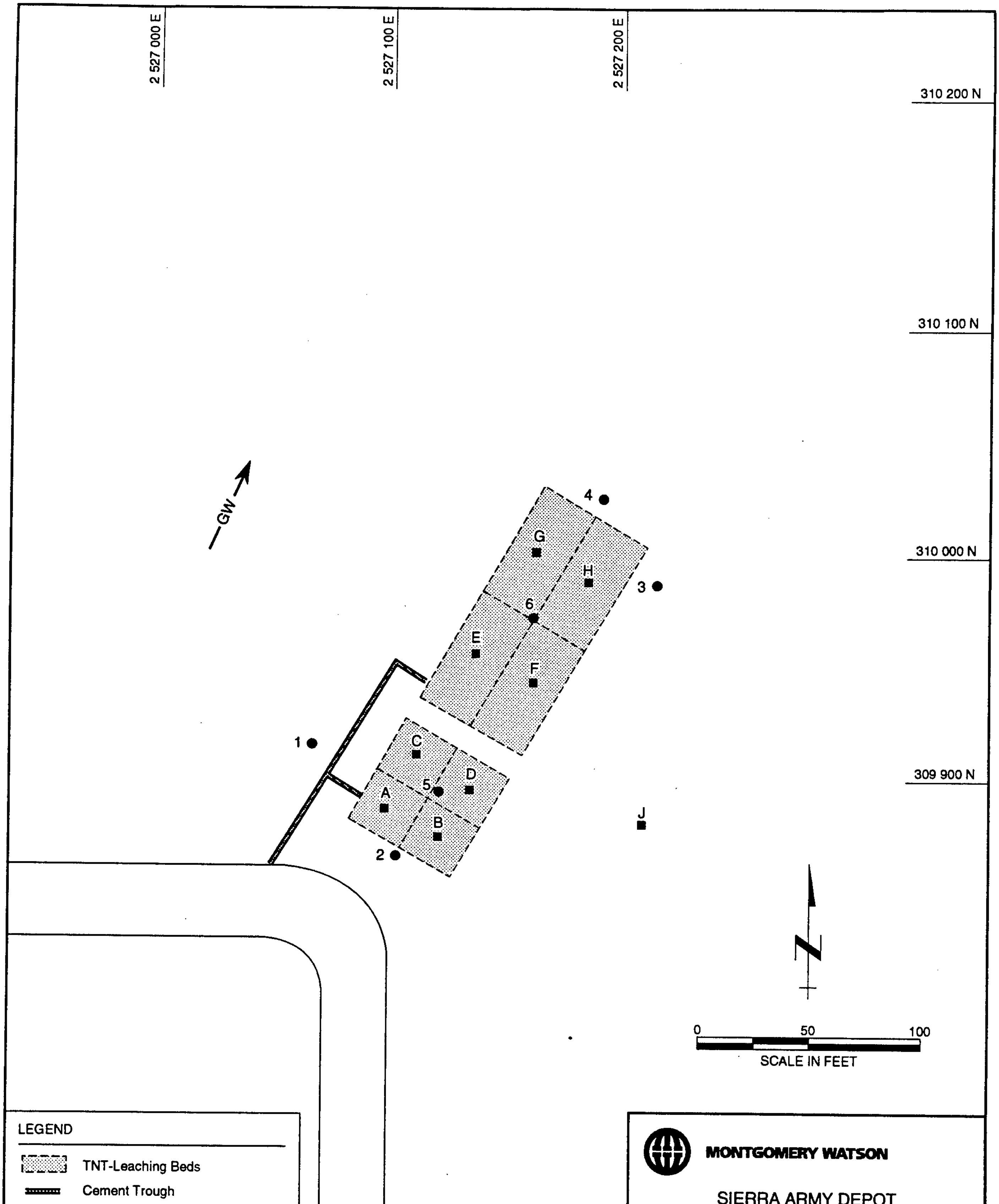
2.5.2.1 Soil. USAEHA conducted several investigations on soils at the TNT Leaching Beds Subsite between 1984 to 1988. Extensive surface and subsurface soil sampling was performed inside the TNT leaching beds during the 1990 Group I RI. During the 1992 Group I Follow-Up RI, surface soil samples were collected around the perimeter of the beds to determine the extent of explosives in soils surrounding the leaching beds.

<u>USAEHA Investigations</u>

Soil contamination in the TNT leaching beds was evaluated by USAEHA in 1984 by collecting composite surface soil samples and by sampling the soils at various depths in six soil borings (Figure 2-17). Eight composite surface soil samples, one from each of four quadrants in each bed, were collected from the leaching beds. Surface samples were analyzed for the Extraction Procedure (EP) toxicity test metals plus copper and explosive compounds. Two additional composite surface soil samples were also collected at this time: one located approximately 60 feet east of the beds for background metals analysis and one from the area north of the two beds (USAEHA, 1984). In October 1984, the eight quadrants in the leaching beds were resampled; one composite surface soil sample was collected from each quadrant for a total of eight samples (USAEHA, 1985).

The only metals detected in surface soil were chromium, lead, and barium; however, the concentrations detected were below background levels.

Table 2-2 summarizes the results from the April and October 1984 analyses for explosives in the composite surface soil samples. 2,4,6-Trinitrotoluene (2,4,6-TNT) was detected at concen-



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PREVIOUS INVESTIGATION SOIL BORING AND COMPOSITE SURFACE SOIL SAMPLE LOCATIONS
TNT LEACHING BEDS AREA

FIGURE 2-17

TABLE 2-2

CONCENTRATIONS OF EXPLOSIVES IN SURFACE SOIL SAMPLES
TNT LEACHING BEDS AREA
APRIL AND OCTOBER, 1984
($\mu g/g$)[a]

Sample[b]	Month Collected	1,3-DNB	2,4-DNT	2,6-DNT	HMX	RDX	Tetryl	1,3,5-TNB	2,4,6-TNT
A	APRIL	NA	12	<1.0	<1.0	<1.0	<5.0	NA	16,000
	OCTOBER	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	15	76
B	APRIL	NA	<1.0	<1.0	<1.0	<1.0	<5.0	NA	20
	OCTOBER	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	7.4	<1.0
C	APRIL	NA	<1.0	<1.0	<1.0	<1.0	<5.0	NA	110
	OCTOBER	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	20	710
D	APRIL	NA	<1.0	<1.0	<1.0	<1.0	<5.0	NA	12
	OCTOBER	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0	19	460
E	APRIL	NA	4.4	<1.0	<1.0	22	<5.0	NA	9,100
	OCTOBER	<1.0	<1.0	<1.0	<1.0	200	<5.0	240	2,400
F	APRIL	NA	3.2	<1.0	<1.0	74	<5.0	NA	4,500
	OCTOBER	<1.0	<1.0	<1.0	<1.0	310	<5.0	140	12,000
G	APRIL	NA	5.1	<1.0	<1.0	190	<5.0	NA	6,700
	OCTOBER	<1.0	<1.0	<1.0	<1.0	390	<5.0	100	5,400
H	APRIL	NA	10	<1.0	<1.0	190	<5.0	NA	16,000
	OCTOBER	<1.0	<1.0	<1.0	<1.0	480	<5.0	87	5,700
I	APRIL	NA	4.4	<1.0	<1.0	160	<5.0	NA	1,300
	OCTOBER	NA	NA	NA	NA	NA	NA	NA	NA
J	APRIL	NA	<1.0	<1.0	<1.0	<1.0	<5.0	NA	76
	OCTOBER	NA	NA	NA	NA	NA	NA	NA	NA

[a] Values given are to two significant figures. NA indicates compound was not analyzed.
[b] See Figure 2-17 for sample locations. Samples are composites over the first 15 cm (6 in.) of soil depth.

Sources: USAEHA, 1984; USAEHA, 1985.

trations of up to 16,000 mg/kg (1.6 percent). Within each bed, the distribution of 2,4,6-TNT over the surface was uneven, especially in the southernmost bed, where concentrations between the different quadrants (samples A through D) varied by factors up to 1,000 or more. The surface samples also contained elevated concentrations of hexahydro-1,3,5-trinitro-1,3,4-triazine (RDX), up to 480 mg/kg, and 1,3,5-trinitrobenzene (1,3,5-TNB), up to 12 mg/kg. None of the samples contained detectable concentrations of cyclotetramethylene tetranitramine (HMX), 2,6-dinitrotoluene (2,6-DNT), tetryl, or 1,3-dinitrobenzene (1,3-DNB) (Benioff et al., 1988). It should be noted that 1,3,5-TNB was not discharged along with the other explosives into the leaching beds. Instead, 1,3,5-TNB is a photolytic degradation product of 2,4,6-trinitrotoluene (2,4,6-TNT).

Six soil borings were also drilled at the TNT Leaching Beds Subsite during the 1984 site investigation. One soil boring was drilled in the northern bed to a depth of 50 feet. Another boring was drilled in the center of the southern bed and four additional borings were drilled outside the beds (Figure 2-17) (USAEHA, 1985). Soil samples were analyzed for both metals and explosives.

Soil samples collected from the six soil borings were analyzed for total copper, barium, cadmium, chromium, lead, selenium, mercury, silver, as well as the EP toxicity metals (USAEHA, 1985). The samples contained low concentrations of total chromium (0.14 to 4.73 mg/kg) and lead (0.25 to 1.02 mg/kg) Selenium concentrations ranging from 0.25 to 1.91 mg/kg were detected at various depths in samples from Borings 1 through 6 (Benioff et al., 1988).

Table 2-3 presents the results of explosive compounds analyses from the soil borings drilled at the TNT Leaching Beds Subsite. The analytical data suggest that a downward migration of explosive residue has occurred beneath the leaching beds. This is especially evident for 1,3,5-TNB, which was detected 50 feet beneath the northern bed at a concentration of 11 mg/kg. 2,4,6-TNT, RDX, and HMX were also present at a depth of 40 feet beneath the northern bed. In borings drilled outside the beds, 1,3,5-TNB was detected at concentrations of up to 28 mg/kg to depths of at least 27 feet. 1,3,5-TNB was detected in the two deepest samples in Borings 1, 2, and 3.

1990 Group I RI

The 1990 Group I RI investigation at the TNT Leaching Beds Subsite included a soil-gas survey, surface soil sampling, and the drilling and sampling of soil borings.

The soil-gas survey did not detect VOCs in or around the TNT Leaching Beds Subsite.

Eight composite surface soil samples were collected to characterize the soil contamination at the TNT Leaching Beds Subsite (Figure 2-18). All of the soil samples were analyzed for priority pollutant metals and explosive compounds. No priority pollutant metals were detected above background levels in the surface soil samples. Explosive compounds were detected in all eight surface soils samples collected from the TNT Leaching Beds Area (Figure 2-18). The total mass

TABLE 2-3

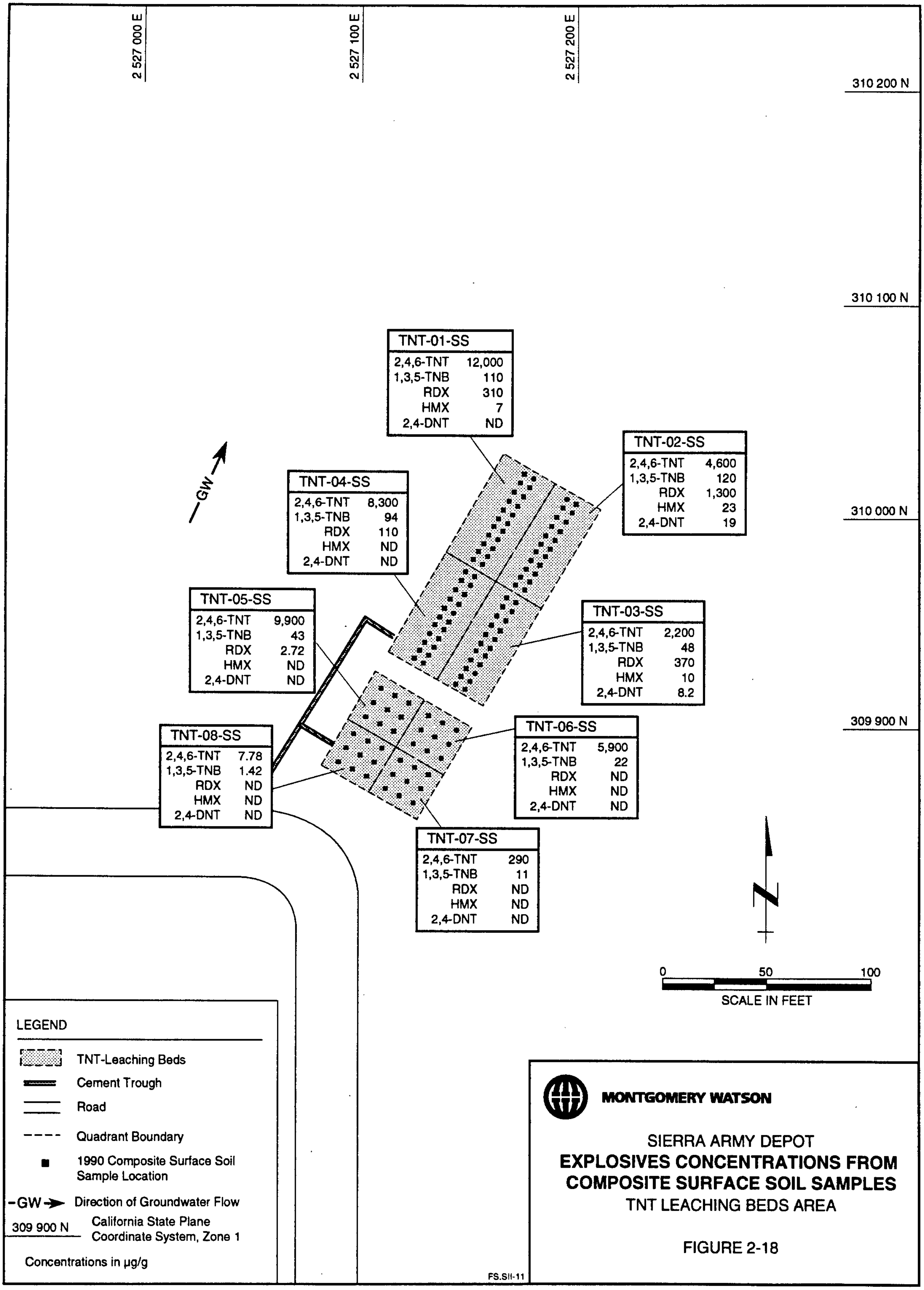
CONCENTRATIONS OF EXPLOSIVES
SUBSURFACE SOIL SAMPLES
TNT LEACHING BEDS AREA
(μg/g)[a]

Borehole[b]	Sample Depth (ft)	HMX	RDX	1,3,5-TNB	2,4,6-TNT
1	0-2	ND	ND	ND	ND
	5-7	ND	ND	ND	ND
	10-12	ND	ND	ND	ND
	16-18	ND	ND	28	ND
	20-22	ND	ND	4.2	ND
2	0-2	ND	ND	ND	ND
	4-6	ND	ND	ND	ND
	9-11	ND	ND	ND	ND
	14-16	ND	ND	6.8	ND
	19-21	ND	ND	5.8	ND
3	5-7	ND	ND	ND	ND
	10-12	ND	ND	ND	ND
	15-17	ND	ND	1.9	ND
	25-27	ND	ND	3.4	ND
4	0-2	ND	ND	ND	ND
	10-12	ND	ND	ND	ND
	15-17	ND	ND	ND	ND
	20-22	ND	ND	ND	ND
5	4-6	ND	ND	11	44
	9-11	ND	ND	27	14
	19-21	ND	ND	16	4.4
6	0-2	<1.0	110	16	194
	4-6	3.9	8.6	11	2.4
	9-11	8.6	25	36	<1.0
	14-16	5.0	4.2	26	8.2
	20-22	5.9	2.8	9.4	7.4
	29-31	2.4	4.5	4.7	5.9
	39-41	3.9	7.3	8.0	7.9
	49-51	<1.0	<1.0	11	<1.0

[a] Values given are to two significant figures. ND indicates parameter was analyzed but not detected. Detection limits were 1 mg/kg for all parameters except tetryl (5 μg/g), which was not detected. Other explosives not detected were 2,4-DNT, 2,6-DNT, and 1,3-DNB.

[b] See Figure 2-17 for borehole locations.
Sources: USAEHA 1984, 1985.

All soil samples were collected in 1984.



SIERRA ARMY DEPOT
EXPLOSIVES CONCENTRATIONS FROM COMPOSITE SURFACE SOIL SAMPLES
TNT LEACHING BEDS AREA

FIGURE 2-18

of both 1,3,5-TNB and total explosives was calculated for the 0- to 2.5-foot interval (Tables 2-4 and 2-5). To calculate the total explosives and 1,3,5-TNB mass in this interval, it was assumed that the concentrations found in the surface soils were representative of the 0- to 2.5-foot interval. Mass was calculated as follows:

$$M = \frac{A \ x \ T}{27 \ ft^3/yd^3} \ x \ \frac{3{,}000 \ lbs}{yd^3} \ x \ \frac{concentration}{10^6}$$

where: M = Mass of compound(s)
A = Surface area of zone
T = Thickness of depth interval

A bulk density of 3,000 pounds per cubic yard (lbs/yd^3) is assumed for soil.

In the 0- to 2.5-foot interval, the mass of total 1,3,5-TNB and explosives is estimated to be 240 pounds, and 20,600 pounds, respectively. It should be noted that the estimated total mass of explosives in this interval is probably much greater than the actual mass since it was assumed that surface soil concentrations are representative of the interval. None of the surface soil samples was determined to be reactive. Based on the ignitability criteria for liquids presented in 22 California Code of Regulations (CCR) §66702, two samples (TNT-01-SS and TNT-05-SS) were determined to be ignitable. Two samples (TNT-05-SS and TNT-05-SS DUP) were determined to be hazardous on the basis of aquatic bioassay tests, as each was found to have an acute 96-hour LC_{50} of less than 500 milligrams per liter when measured in soft water with fathead minnows.

Eight soil borings (four per bed), TNT-12-SB through TNT-19-SB, were drilled and sampled at 5-foot intervals at the TNT Leaching Beds Subsite (Figure 2-19). Thirty-five samples were collected and analyzed for VOCs. A total of 80 samples, collected from the eight borings, were analyzed for priority pollutant metals and explosives.

TCE was detected in only two subsurface soil samples collected from the TNT leaching beds. TCE was detected in the 40-foot interval in Boring TNT-12-SB (0.003 mg/kg), and at the 5-foot interval in Boring TNT-13-SB (0.028 mg/kg). The source of the TCE is considered to be random dumping of TCE either directly into the beds or into the concrete troughs that empty into the beds.

No priority pollutant metals were detected above background levels in the subsurface soil samples.

Explosive compounds were detected in 98 percent of the subsurface soil samples collected from the TNT Leaching Beds Subsite (Figure 2-19). 1,3,5-TNB was detected in 93 percent of the subsurface soil samples, making it the most widely distributed explosives compound.

TABLE 2-4

TOTAL EXPLOSIVES MASS
TNT LEACHING BEDS SUBSITE
(lbs.)

Depth Interval (ft.)	Sample Depth (ft.)	Zone 12 Mass (lbs.)	Zone 13 Mass (lbs.)	Zone 14 Mass (lbs.)	Zone 15 Mass (lbs.)	Zone 16 Mass (lbs.)	Zone 17 Mass (lbs.)	Zone 18 Mass (lbs.)	Zone 19 Mass (lbs.)	Total lbs.
0-2.5	0.5	7,250	3,621	1,441	4,719	1,654	1,793	91.24	2.78	20,572
2.5-7.5	5.0	131.14	43.07	31.67	45.35	21.70	11.82	14.54	14.30	313.59
7.5-12.5	10.0	90.51	41.24	25.13	29.12	21.74	13.06	13.27	16.02	250.29
12.5-17.5	15.0	89.13	51.86	2.45	42.81	25.45	10.10	21.94	6.55	253.29
17.5-22.5	20.0	35.46	45.21	17.80	13.80	10.70	3.99	2.63	2.71	132.30
22.5-27.5	25.0	34.80	98.52	13.27	47.57	4.55	5.99	4.89	2.79	212.38
27.5-32.5	30.0	23.83	17.71	8.60	13.50	3.37	3.00	3.46	1.65	75.12
32.5-37.5	35.0	27.47	14.79	18.41	11.55	6.64	7.37	7.31	7.39	100.93
37.5-42.5	40.0	3.27	26.74	4.75	24.37	6.22	11.48	4.53	7.83	89.19
42.5-47.5	45.0	2.17	7.50	15.01	19.26	1.26	1.31	1.56	ND	49.07
47.5-52.5	50.0	4.97	10.24	19.83	5.43	1.04	9.01	0.44	ND	50.96
Total (lbs)		7,694	3,977	1,601	4,972	1,756	1,870	166	62.02	22,099
Area of Zone (ft^2)		2,170	2,170	1,995	1,995	1,088	1,088	1,088	1,088	12,682

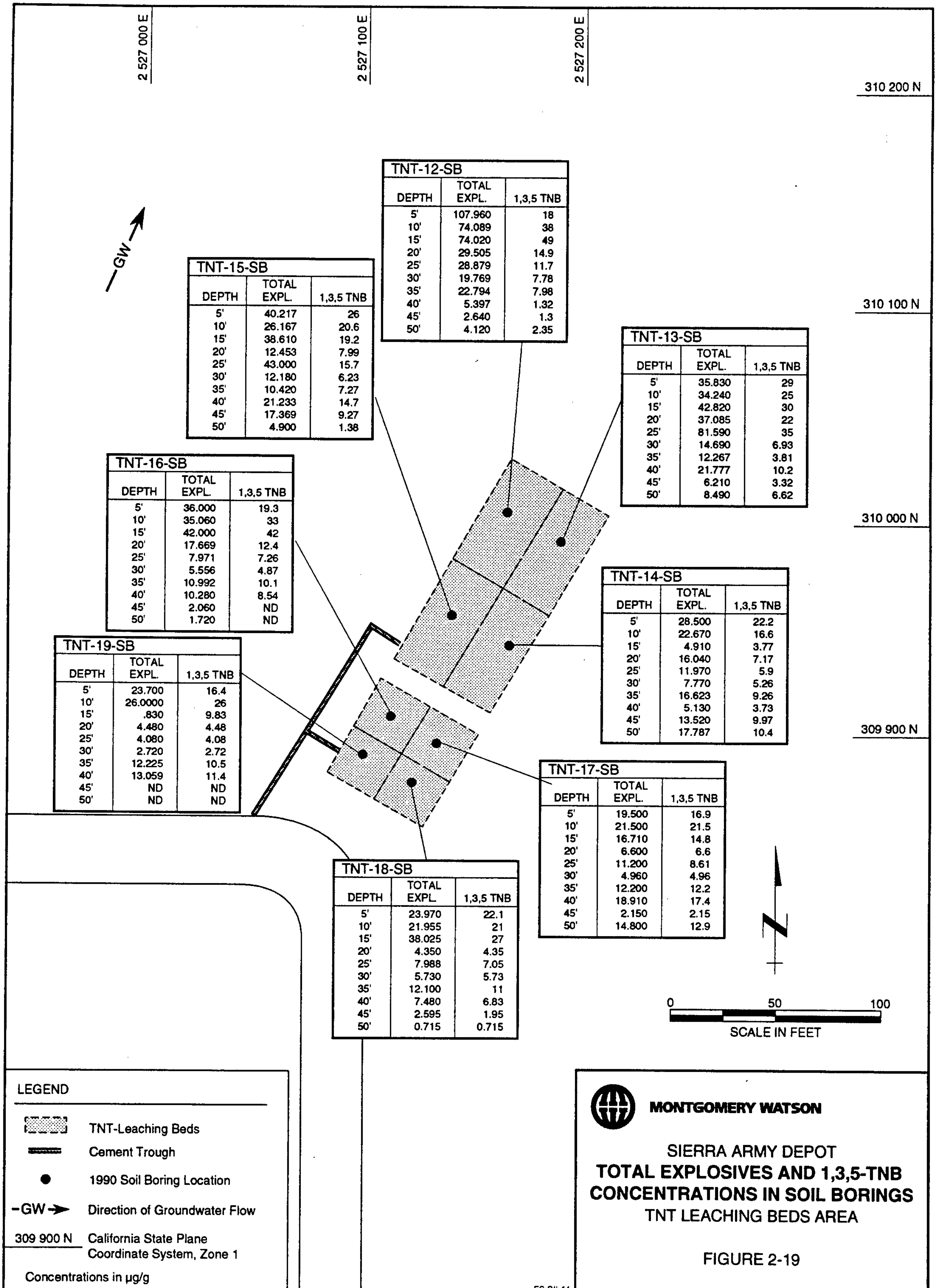
ND - Not detected

TABLE 2-5

1,3,5-TNB MASS
TNT LEACHING BEDS SUBSITE
(lbs.)

Depth Interval (ft.)	Sample Depth (ft.)	Zone 12 Mass (lbs.)	Zone 13 Mass (lbs.)	Zone 14 Mass (lbs.)	Zone 15 Mass (lbs.)	Zone 16 Mass (lbs.)	Zone 17 Mass (lbs.)	Zone 18 Mass (lbs.)	Zone 19 Mass (lbs.)	Total lbs
0-2.5	0.5	66.91	74.74	26.43	51.70	12.87	6.83	3.29	0.43	243.20
2.5-7.5	5.0	22.18	34.84	24.60	31.81	11.68	10.22	13.42	9.85	158.60
7.5-12.5	10.0	47.02	30.14	18.40	22.94	20.51	13.07	12.69	16.02	180.79
12.5-17.5	15.0	58.95	36.41	4.18	21.28	25.47	8.95	16.68	5.94	177.86
17.5-22.5	20.0	17.84	27.00	7.95	8.86	7.50	3.99	2.63	2.71	78.48
22.5-27.5	25.0	14.11	42.44	6.54	17.29	4.33	5.99	4.45	2.79	97.94
27.5-32.5	30.0	9.37	8.35	5.82	6.90	2.95	3.00	3.46	1.65	41.50
32.5-37.5	35.0	9.62	4.59	10.29	8.06	6.11	7.38	6.65	6.35	59.05
37.5-42.5	40.0	1.30	12.90	4.15	16.19	5.17	10.59	4.13	6.83	61.26
42.5-47.5	45.0	1.57	4.01	11.06	10.29	ND	1.31	1.17	ND	29.41
47.5-52.5	50.0	2.83	7.98	11.64	1.53	ND	7.86	0.44	ND	32.28
Total (lbs)		252	283	131	197	97	79	69	53	1,160
Area of Zone (ft^2)		2,170	2,170	1,995	1,995	1,088	1,088	1,088	1,088	12,682

ND - Not detected



TNT-12-SB

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	107.960	18
10'	74.089	38
15'	74.020	49
20'	29.505	14.9
25'	28.879	11.7
30'	19.769	7.78
35'	22.794	7.98
40'	5.397	1.32
45'	2.640	1.3
50'	4.120	2.35

TNT-15-SB

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	40.217	26
10'	26.167	20.6
15'	38.610	19.2
20'	12.453	7.99
25'	43.000	15.7
30'	12.180	6.23
35'	10.420	7.27
40'	21.233	14.7
45'	17.369	9.27
50'	4.900	1.38

TNT-13-SB

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	35.830	29
10'	34.240	25
15'	42.820	30
20'	37.085	22
25'	81.590	35
30'	14.690	6.93
35'	12.267	3.81
40'	21.777	10.2
45'	6.210	3.32
50'	8.490	6.62

TNT-16-SB

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	36.000	19.3
10'	35.060	33
15'	42.000	42
20'	17.669	12.4
25'	7.971	7.26
30'	5.556	4.87
35'	10.992	10.1
40'	10.280	8.54
45'	2.060	ND
50'	1.720	ND

TNT-14-SB

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	28.500	22.2
10'	22.670	16.6
15'	4.910	3.77
20'	16.040	7.17
25'	11.970	5.9
30'	7.770	5.26
35'	16.623	9.26
40'	5.130	3.73
45'	13.520	9.97
50'	17.787	10.4

TNT-19-SB

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	23.700	16.4
10'	26.0000	26
15'	.830	9.83
20'	4.480	4.48
25'	4.080	4.08
30'	2.720	2.72
35'	12.225	10.5
40'	13.059	11.4
45'	ND	ND
50'	ND	ND

TNT-17-SB

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	19.500	16.9
10'	21.500	21.5
15'	16.710	14.8
20'	6.600	6.6
25'	11.200	8.61
30'	4.960	4.96
35'	12.200	12.2
40'	18.910	17.4
45'	2.150	2.15
50'	14.800	12.9

TNT-18-SB

DEPTH	TOTAL EXPL.	1,3,5 TNB
5'	23.970	22.1
10'	21.955	21
15'	38.025	27
20'	4.350	4.35
25'	7.988	7.05
30'	5.730	5.73
35'	12.100	11
40'	7.480	6.83
45'	2.595	1.95
50'	0.715	0.715

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TOTAL EXPLOSIVES AND 1,3,5-TNB CONCENTRATIONS IN SOIL BORINGS

TNT LEACHING BEDS AREA

FIGURE 2-19

1992 Group I Follow-Up RI

Twenty-two composite surface soil samples were collected in a grid surrounding the TNT leaching beds during the 1992 Group I Follow-Up investigation. Samples were concentrated in the area to the north of the leaching beds where red soil staining indicative of weathered TNT was observed. Samples were analyzed for explosive compounds.

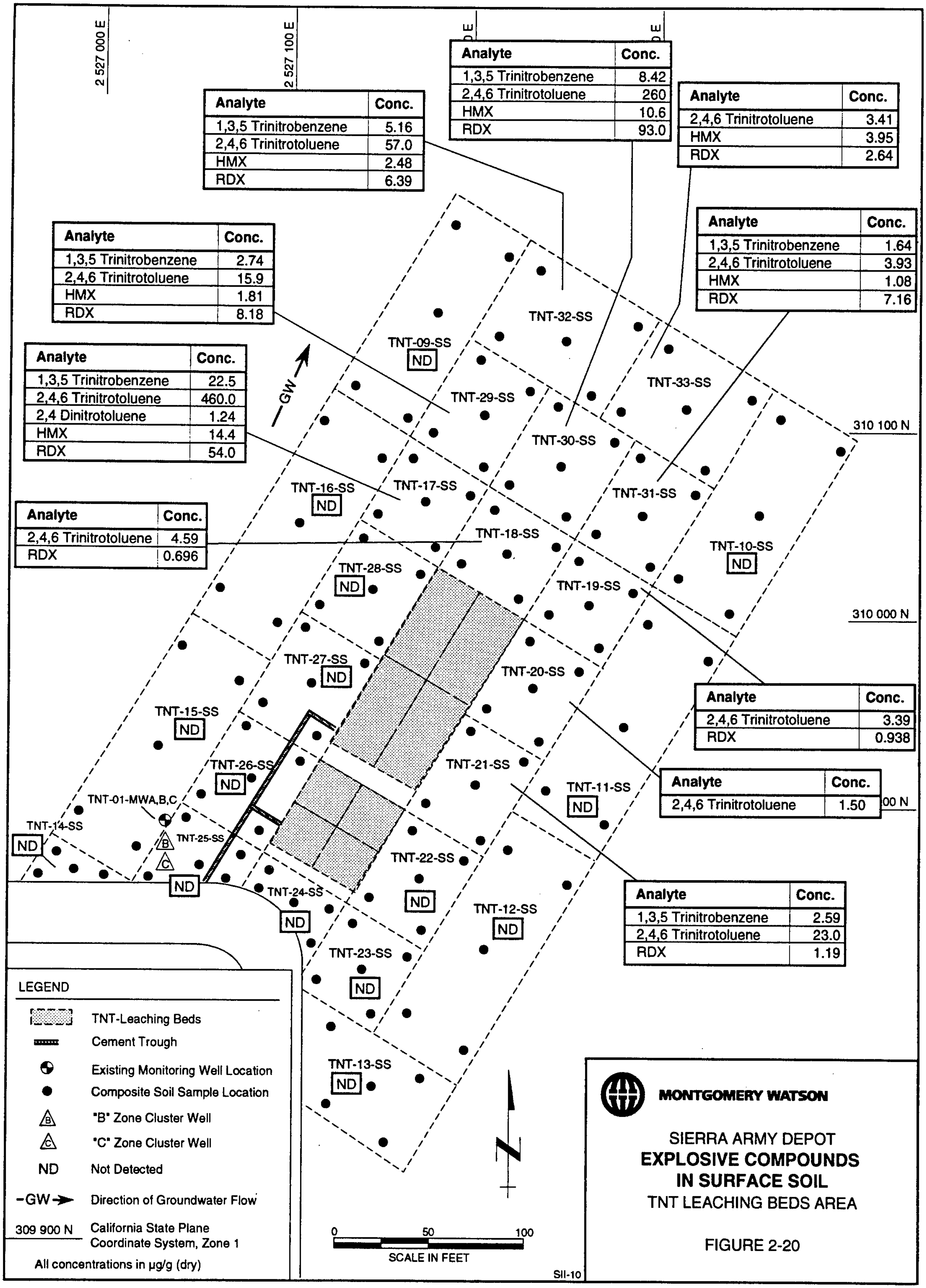
Explosive compounds were detected in 10 of 22 composite surface soil samples collected and analyzed from the area surrounding the TNT Leaching Beds. Explosive compounds detected were 1,3,5-TNB; 2,4,6-TNT; 2,4-DNT; HMX; and RDX (Figure 2-20). These compounds were also detected in the leaching beds during the 1990 Group I RI. The highest concentrations were detected in the area to the north of the beds where the soil staining had been observed; however, the maximum concentrations detected outside the leaching beds are less than 4 percent of those detected inside the beds. The stained area is wholly within the sampled area and appears to be limited to the upper 2 feet of soil in most locations. Based on the distribution of explosives in soil, it is interpreted that soil may have been excavated periodically from the leaching beds and placed in the area north of the leaching beds.

2.5.2.2 Groundwater. Groundwater at the TNT Leaching Beds Subsite was investigated by USAEHA from 1984 to 1988, and by Montgomery Watson as part of the 1990 Group I RI, 1991 Group II RI, and 1992 Group I Follow-Up RI field investigations.

The following discussion on the nature and extent of groundwater contamination at the TNT Leaching Beds Subsite focuses on data collected from six rounds of sampling conducted over a 3-year period (1990 through 1992) on eight "A" zone monitoring wells, three "B" zone monitoring wells, and three "C" zone monitoring wells. The wells sampled are listed below:

- TNT-01-MWA
- TNT-01-MWB
- TNT-01-MWC
- TNT-02-MWA
- TNT-02-MWB
- TNT-02-MWC
- TNT-03-MWA
- TNT-04-MWA
- TNT-06-MWA
- TNT-07-MWA
- TNT-07-MWB
- TNT-07-MWC
- TNT-08-MWA
- TNT-09-MWA

These wells were sampled for two successive periods during the 1990 Group I RI and most were sampled for two successive periods during the 1991 Group II RI. Samples collected from the monitoring wells were analyzed for extractable organic compounds (pesticides/PCBs and



2 527 000 E
2 527 100 E
Analyte | Conc.
1,3,5 Trinitrobenzene | 5.16
2,4,6 Trinitrotoluene | 57.0
HMX | 2.48
RDX | 6.39
Analyte | Conc.
1,3,5 Trinitrobenzene | 8.42
2,4,6 Trinitrotoluene | 260
HMX | 10.6
RDX | 93.0
Analyte | Conc.
2,4,6 Trinitrotoluene | 3.41
HMX | 3.95
RDX | 2.64
Analyte | Conc.
1,3,5 Trinitrobenzene | 1.64
2,4,6 Trinitrotoluene | 3.93
HMX | 1.08
RDX | 7.16
Analyte | Conc.
1,3,5 Trinitrobenzene | 2.74
2,4,6 Trinitrotoluene | 15.9
HMX | 1.81
RDX | 8.18
Analyte | Conc.
1,3,5 Trinitrobenzene | 22.5
2,4,6 Trinitrotoluene | 460.0
2,4 Dinitrotoluene | 1.24
HMX | 14.4
RDX | 54.0
Analyte | Conc.
2,4,6 Trinitrotoluene | 4.59
RDX | 0.696
Analyte | Conc.
2,4,6 Trinitrotoluene | 3.39
RDX | 0.938
Analyte | Conc.
2,4,6 Trinitrotoluene | 1.50
Analyte | Conc.
1,3,5 Trinitrobenzene | 2.59
2,4,6 Trinitrotoluene | 23.0
RDX | 1.19
GW
TNT-32-SS
TNT-09-SS
ND
TNT-33-SS
TNT-29-SS
TNT-30-SS
310 100 N
TNT-16-SS
ND
TNT-17-SS
TNT-31-SS
TNT-18-SS
TNT-10-SS
ND
TNT-28-SS
ND
TNT-19-SS
310 000 N
TNT-27-SS
ND
TNT-20-SS
TNT-15-SS
ND
TNT-26-SS
ND
TNT-21-SS
TNT-11-SS
ND
TNT-01-MWA,B,C
TNT-14-SS
ND
TNT-25-SS
ND
TNT-22-SS
TNT-24-SS
ND
ND
TNT-12-SS
ND
TNT-23-SS
ND
TNT-13-SS
ND
LEGEND
TNT-Leaching Beds
Cement Trough
Existing Monitoring Well Location
Composite Soil Sample Location
"B" Zone Cluster Well
"C" Zone Cluster Well
ND Not Detected
-GW→ Direction of Groundwater Flow
309 900 N California State Plane Coordinate System, Zone 1
All concentrations in µg/g (dry)
0 50 100
SCALE IN FEET
SII-10
MONTGOMERY WATSON
SIERRA ARMY DEPOT
EXPLOSIVE COMPOUNDS
IN SURFACE SOIL
TNT LEACHING BEDS AREA
FIGURE 2-20

SVOCs), VOCs, priority pollutant metals, and explosive compounds. Most of the TNT Leaching Beds Subsite wells were also sampled for two successive rounds during the 1992 Group I Follow-Up RI and analyzed for priority pollutant metals, VOCs, and explosive compounds. A summary of organic and explosive compounds detected in groundwater at the TNT Leaching Beds Subsite is presented in Table 2-1.

Several metals were detected in "A" zone wells at the TNT Leaching Beds Area. Selenium and chromium were detected above their respective California MCLs. Since a soil source was not identified for selenium, the selenium values detected at this site may represent anomalously high background levels. Chromium was detected in five of 16 "A" zone wells and one of four "C" zone wells at the TNT Leaching Beds Area. The California and federal chromium MCLs (both 50 μg/l) were exceeded in only one sample from the "A" zone wells at a concentration of 226 μg/l. If the 226 μg/l sample is omitted, the average concentration of chromium in all wells is only 10.6 μg/l. Since only one sample out of 16 "A" zone wells exceeds chromium MCLs and no source of chromium was shown to exist in soils, the Army does not plan to treat groundwater for chromium. Chromium has not been detected in background groundwater samples; the CRL for chromium is 6.2 μg/l.

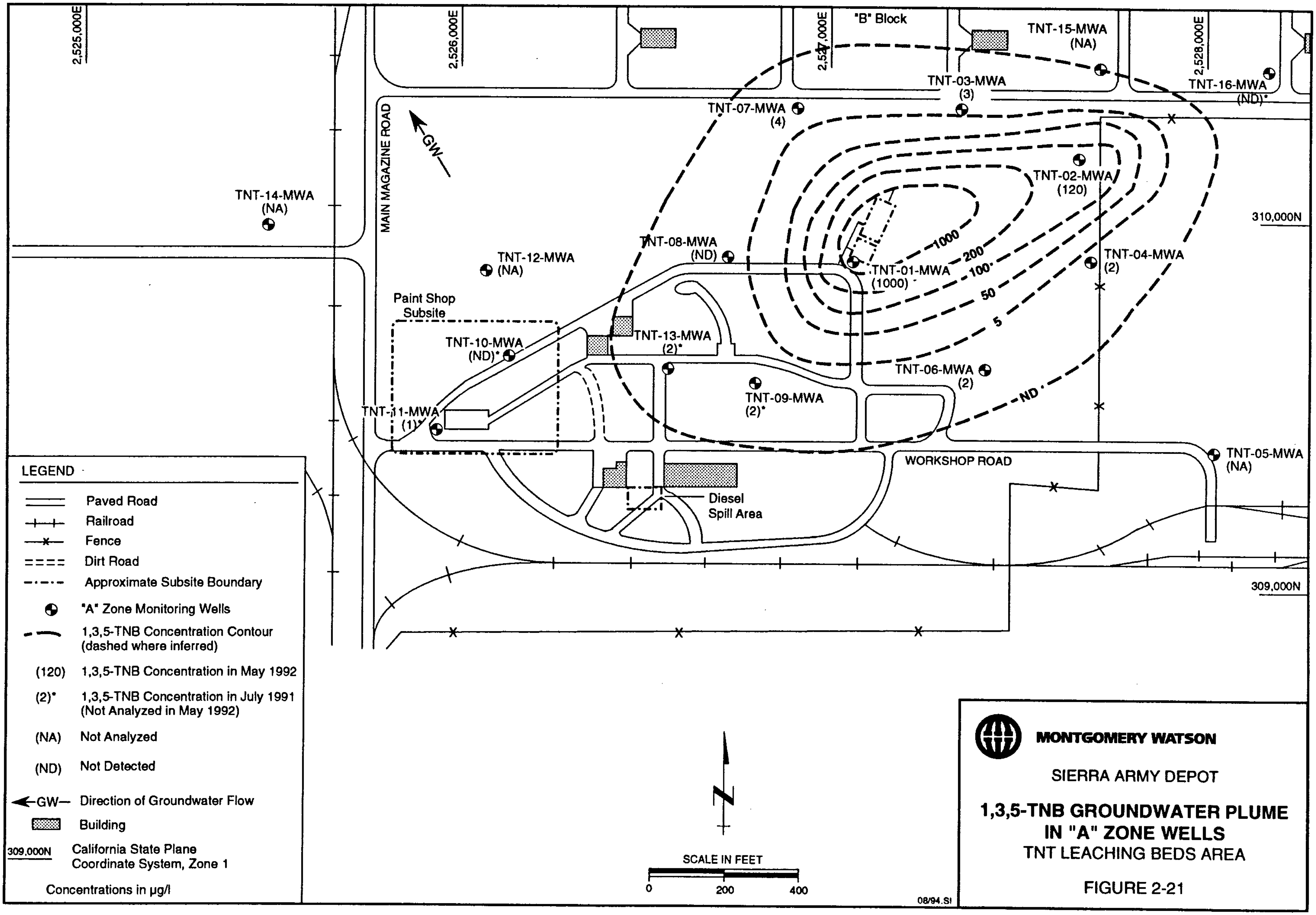
Other metals detected in the "A" zone wells included arsenic, barium, lead, and mercury. State MCLs were not exceeded for these metals and their concentrations are considered to represent background levels. Arsenic, barium, and zinc were detected in all three "B" zone wells. Arsenic and barium were detected in the "C" zone well. The maximum concentrations of arsenic, barium, and zinc detected in background groundwater samples are 290 μg/l, and 117 μg/l, respectively. Mercury has not been detected in background groundwater samples; the CRL for mercury is 0.243 μg/l.

High levels of explosives have been detected in 10 "A" zone wells at the TNT Leaching Beds Subsite. 1,3,5-TNB was detected in eight of the "A" zone wells, making it the most widely distributed explosive compound in groundwater at this site. A groundwater plume of explosive compounds is presented in Figure 2-21. This plume is only slightly elongated in the direction of groundwater flow due to the low hydraulic gradient and groundwater velocity at the site. The data indicate that 1,3,5-TNB concentrations have remained constant in these wells over a 3-year period and have decreased in two monitoring wells, TNT-02-MWA and TNT-03-MWA (Table 2-1).

Bis(2-ethylhexyl)phthalate and 2,4-dinitrophenol were the only SVOCs detected in groundwater at this site.

Low levels of TCE, 1,2-DCA, chloroform, and carbon tetrachloride were detected in groundwater. TCE was detected in three of eight "A" zone wells (Table 2-1). TCE concentrations in two wells were above the MCL (5 μg/l).

The eastern lobe of the bilobate TCE plume shown in Figure 2-16 is centered around the TNT leaching beds. The TCE source at this subsite is postulated to be random dumping into the TNT leaching beds. The western lobe which is centered around the Paint Shop Subsite has a



2,525,000E
2,526,000E
2,527,000E
2,528,000E
310,000N
309,000N
"B" Block
TNT-15-MWA (NA)
TNT-16-MWA (ND)*
TNT-03-MWA (3)
TNT-07-MWA (4)
TNT-02-MWA (120)
TNT-14-MWA (NA)
MAIN MAGAZINE ROAD
GW
TNT-08-MWA (ND)
TNT-01-MWA (1000)
1000
200
100
50
5
ND
TNT-04-MWA (2)
TNT-12-MWA (NA)
Paint Shop Subsite
TNT-10-MWA (ND)*
TNT-13-MWA (2)*
TNT-06-MWA (2)
TNT-09-MWA (2)*
TNT-11-MWA (1)*
TNT-05-MWA (NA)
WORKSHOP ROAD
Diesel Spill Area
LEGEND
Paved Road
Railroad
Fence
Dirt Road
Approximate Subsite Boundary
"A" Zone Monitoring Wells
1,3,5-TNB Concentration Contour (dashed where inferred)
(120) 1,3,5-TNB Concentration in May 1992
(2)* 1,3,5-TNB Concentration in July 1991 (Not Analyzed in May 1992)
(NA) Not Analyzed
(ND) Not Detected
GW Direction of Groundwater Flow
Building
309,000N California State Plane Coordinate System, Zone 1
Concentrations in µg/l
N
SCALE IN FEET
0
200
400
08/94.SI
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SIERRA ARMY DEPOT
1,3,5-TNB GROUNDWATER PLUME IN "A" ZONE WELLS
TNT LEACHING BEDS AREA
FIGURE 2-21

maximum TCE concentration of 1,000 μg/l. This lobe is oriented in a northwesterly direction. The lobes of the plume are only slightly elongated in the direction of groundwater flow due to the low hydraulic gradient and groundwater velocity at the site. Modeling results of TCE groundwater movement suggests that the plume is relatively immobile.

2.5.2.3 TNT Leaching Beds Area Summary. Explosives are the primary soil contaminants at the TNT Leaching Beds Subsite. Explosives were detected in all of the surface soils and 98 percent of the subsurface soils within and directly beneath the leaching beds. 1,3,5-TNB had the highest frequency of occurrence (93 percent of subsurface soils). The mass of total explosives in the vadose zone is estimated to be 22,100 pounds. The mass in the 0- to 2.5-foot interval is estimated to be 20,600 pounds, or 93 percent of the total mass in the vadose zone. The mass of 1,3,5-TNB in the vadose zone beneath the TNT leaching beds is estimated to be 1,160 pounds, or 5 percent of the total explosives mass. The 1,3,5-TNB mass in the 0- to 2.5-foot interval is estimated to be 240 pounds, or 21 percent of the 1,3,5-TNB mass in the vadose zone. The fact that 1,3,5-TNB is more evenly distributed throughout the vadose zone than are other explosives is indicative of the greater mobility of this compound.

Composite surface soil samples collected in the area surrounding the TNT leaching beds indicated that explosive compounds are present in the area north of the beds and on the eastern and western sides of the northern bed. Explosive compounds were detected at concentrations less than 4 percent of those detected inside the leaching beds. Soil staining in these areas suggests that explosive compounds are present to a depth of less than 2 feet. It is interpreted that a small quantity of soil may have been excavated from the leaching beds and placed in the surrounding areas.

High levels of explosives have been detected in groundwater beneath the TNT Leaching Beds Subsite. 1,3,5-TNB is the most widely distributed explosive compound detected in groundwater. In addition, low levels of TCE have been detected in groundwater beneath the TNT Leaching Beds Subsite.

2.5.3 Diesel Spill Area

This section discusses the nature and extent of soil and groundwater contamination at the Diesel Spill Area. Previous investigations at the Diesel Spill Area have included:

- Excavation in 1987 of contaminated soil in the vicinity of the diesel spill
- Installation of monitoring well DF-01-MWA in 1988
- 1991 Group II RI
- Two rounds of groundwater sampling during the 1992 Group I Follow-Up Remedial Investigation
- SCAPS investigation in 1993

Results of the investigations conducted prior to the 1993 SCAPS investigation are discussed in Section 2.5.3.1. Section 2.5.3.2 discusses the results of the 1993 SCAPS investigation.

2.5.3.1 Previous Investigations. Previous investigations at the Diesel Spill Area include excavation of the spill area and soil sampling, installation of soil borings, and installation and sampling of monitoring wells.

Soil. The diesel spill occurred at a bend in an underground line near the location of monitoring well DF-01-MWA (Figure 2-22). The spill area was excavated in 1987, lined with plastic sheeting, and backfilled with clean soil. The backfill was covered with another layer of plastic lining and an additional foot of topsoil was added. The excavation was stopped because it threatened to undermine the foundation of Building 403. The reported depth of the excavation was a maximum 30 feet (Benioff, et al., 1988); however, cone penetrometer data show a maximum thickness of approximately 18 feet of fill near monitoring well DF-01-MWA. Soil samples were collected and analyzed for oil and grease at a total of 10 locations on April 16, 1987 and June 22, 1987, and two locations on July 29, 1987 (Benioff et al., 1988).

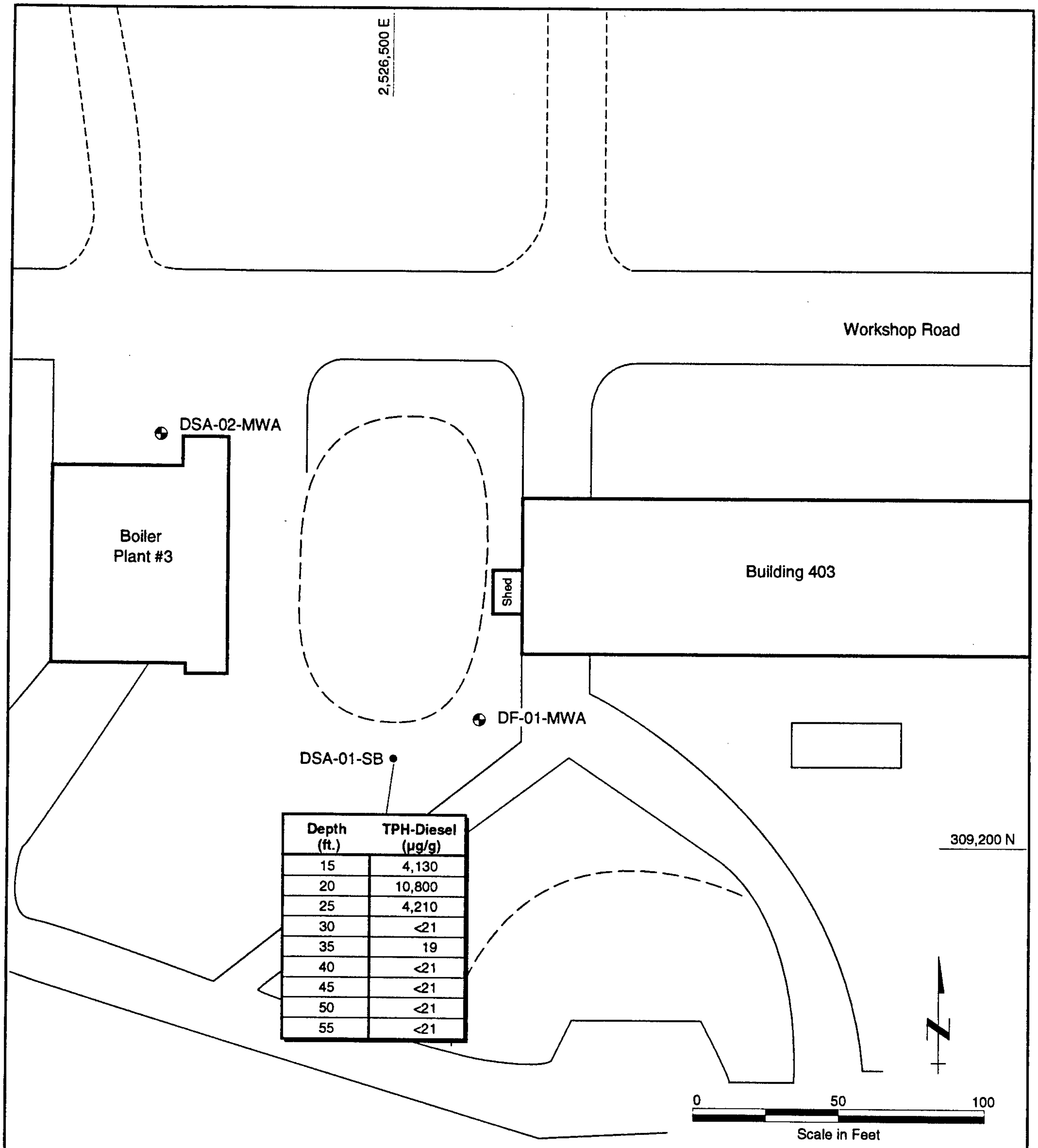
During the 1991 Group II RI (JMM, 1992), one soil boring, DSA-01-SB, was drilled to a depth of 60 feet near the center of the site to define the vertical extent of contamination (Figure 2-22). Because this area had been previously excavated, lined with plastic, and backfilled with clean soil, soil sampling started at 15 feet, the depth at which the liner was first encountered. Ten soil samples were collected at 5-foot intervals to the water table, which was encountered at a depth of about 60 feet. Soil samples were analyzed for benzene, ethylbenzene, toluene, and xylenes (BETX), total petroleum hydrocarbons (TPH-diesel [modified EPA Method 8015]), and total organic carbon (TOC). Alternate samples were analyzed for SVOCs.

As shown in Figure 2-22, TPH-diesel was detected between the 15-foot interval down to the 35-foot interval. The highest concentration was detected in the 20-foot interval at 10,800 mg/kg. No TPH-diesel was detected below 35 feet.

Four different SVOCs (fluorene, naphthalene, phenanthrene, and 2-methylnaphthalene) were detected in two of the five soil samples collected from boring DSA-01-SB. All SVOCs detected are components of diesel fuel.

No VOCs were detected in the soil samples from DSA-01-SB except for very low levels of toluene in the 15- and 55-foot samples.

Groundwater. Prior to the 1993 SCAPS investigation, the extent of groundwater contamination at the Diesel Spill Area was defined by two wells: DF-01-MWA and DSA-02-MWA (Figure 2-22). Well DF-01-MWA was installed in 1987 by the U.S. Army Environmental Hygiene Agency (USAEHA), and DSA-02-MWA was installed by Montgomery Watson during the 1991 Group II RI. Four rounds of groundwater sampling were performed on these two wells between 1991 and 1992. During the first two rounds of sampling (1991) the groundwater was analyzed for VOCs, SVOCs, priority pollutant metals, TPH-diesel, and water quality parameters. During sampling Rounds 3 and 4 (1992) the groundwater was analyzed for VOCs, SVOCs, and



Depth (ft.)	TPH-Diesel (µg/g)
15	4,130
20	10,800
25	4,210
30	<21
35	19
40	<21
45	<21
50	<21
55	<21

LEGEND

- Monitoring Well Location
- Soil Boring Location
- Paved Road
- Earthen Barricades
- Dirt Road
- Building
- 309000 N — California State Plane Coordinate System, Zone 1

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SIERRA ARMY DEPOT
DIESEL SPILL AREA
1991 AND 1992
SAMPLING LOCATIONS

FIGURE 2-22

01/94.SI

TPH-diesel. A summary of organic compounds detected in groundwater at the Diesel Spill Area in 1991 and 1992 is presented in Table 2-6.

Lead was detected at 14.2 μg/l in the Round 1 groundwater sample collected from DF-01-MWA. This concentration is above the background level for lead in groundwater at SIAD (0.9 μg/l). However, lead was not detected above background in the Round 2 samples. No other metals were detected above concentrations believed to be representative of background conditions. Groundwater at the Diesel Spill Area was not analyzed for metals during the 1992 Group I Follow-Up RI.

TPH-diesel was detected in DF-01-MWA during all four rounds of groundwater sampling. Free product was measured in this well during the first and second rounds of sampling at 2.5 inches and 0.13 inches, respectively. The free product was removed from the well and groundwater samples were collected. However, the presence of free product in the well affected the analytical results. TPH-diesel was detected at concentrations of 250,000 μg/l and 290,000 μg/l during the first and second rounds, respectively. Free product measured during the third round was approximately 0.13 inches thick and during the fourth round only a sheen of diesel was observed. TPH-diesel was detected at concentrations of 21,000 μg/l and 970 μg/l in the third and fourth rounds, respectively. The high levels of TPH-diesel that were detected during the first three rounds of sampling probably reflect accumulation of free product in the monitoring well and probably do not represent the true concentration of TPH-diesel in the aquifer. During the fourth round of sampling only a sheen of diesel fuel was present prior to purging of the well. Therefore, the analytical data for Round 4 are probably not as significantly affected. TPH-diesel was not detected in the downgradient monitoring well DSA-02-MWA during any of the four sampling rounds.

SVOCs detected in DF-01-MWA include pyrene at 7.34 μg/l (Round 2) and 3.22 μg/l (Round 3); 2-methylnaphthalene at 381 μg/l (Round 1), 21.8 μg/l (Round 3), and 2.39 μg/l (Round 4); bis(2-ethylhexyl)phthalate at 5.36 μg/l (Round 3) and 19.1 μg/l (Round 4); and phenanthrene at 150 μg/l (Round 1) and 7.8 μg/l (Round 3). No SVOCs were detected in DSA-02-MWA. It is suspected that bis(2-ethylhexyl)phthalate is a laboratory contaminant. There are no federal or California MCLs for the SVOCs detected.

VOCs were only detected in the first round of groundwater samples collected from DF-01-MWA and include chloromethane (4.5 μg/l), ethylbenzene (0.91 μg/l), and xylenes (30 μg/l). These compounds were not detected in DF-01-MWA in any of the three subsequent rounds.

Carbon tetrachloride, chloroform, methylene chloride, and TCE were detected in DSA-02-MWA during all rounds of sampling in 1991 and 1992. These compounds are not associated with the diesel spill but instead are probably part of the VOC plume originating from the Paint Shop site located northwest of the Diesel Spill Area (Figure 2-16).

2.5.3.2 SCAPS Investigation. A field investigation termed the SCAPS investigation was performed from September 28 through November 24, 1993 to provide additional site characterization data to be incorporated into the FS that was prepared for the site (Montgomery

TABLE 2-6

ORGANIC COMPOUNDS IN GROUNDWATER
DIESEL SPILL AREA MONITORING WELLS

Monitoring Well	Concentration (µg/l)			
	Round 1 Apr-91	Round 2 Jul-91	Round 3 Mar-92	Round 4 May-92
DF-01-MWA				
Petroleum Hydrocarbons				
TPH-diesel	250,000	290,000	21,000	970
VOCs				
Chloromethane	4.5	<3.2	<3.2	<3.2
Ethylbenzene	0.91	<0.5	<0.5	<0.5
Xylenes	30	<0.84	<0.84	<0.84
SVOCs				
2-methylnaphthalene	381	<1.7	21.8	2.39
Bis(2-ethylhexyl)phthalate	<200	<4.8	5.36	19.1
Phenanthrene	150	<0.5	7.8	<0.5
Pyrene	<100	7.34	3.22	<2.8
DSA-02-MWA				
Petroleum Hydrocarbons				
TPH-diesel	<2.5	<2.5	<2,500	<410
VOCs				
Trichloroethene	53.3	21.9	17.5	16.2
Carbon tetrachloride	22.9	5.24	2.87	2.1
Chloroform	13.3	3.38	2.6	2.4
Methylene chloride	<2.3	4.25	<2.3	<2.3
Xylenes	<0.84	<0.84	1.1	<0.84
SVOCs				
Bis(2-ethylhexyl)phthalate	<4.8	<4.8	16.8	<4.8

Watson, 1994). The SCAPS is an experimental cone penetrometer test (CPT), chemical sensor, and sampling system developed by the U.S. Army Corps of Engineers, Waterways Experiment Station (WES) and the USAEC. The SCAPS investigation was performed by the WES under the direction of the USAEC. Montgomery Watson provided laboratory analyses, data management, and field support for the SCAPS investigation. Descriptions of the nature and extent of contamination based on the SCAPS investigation are presented below.

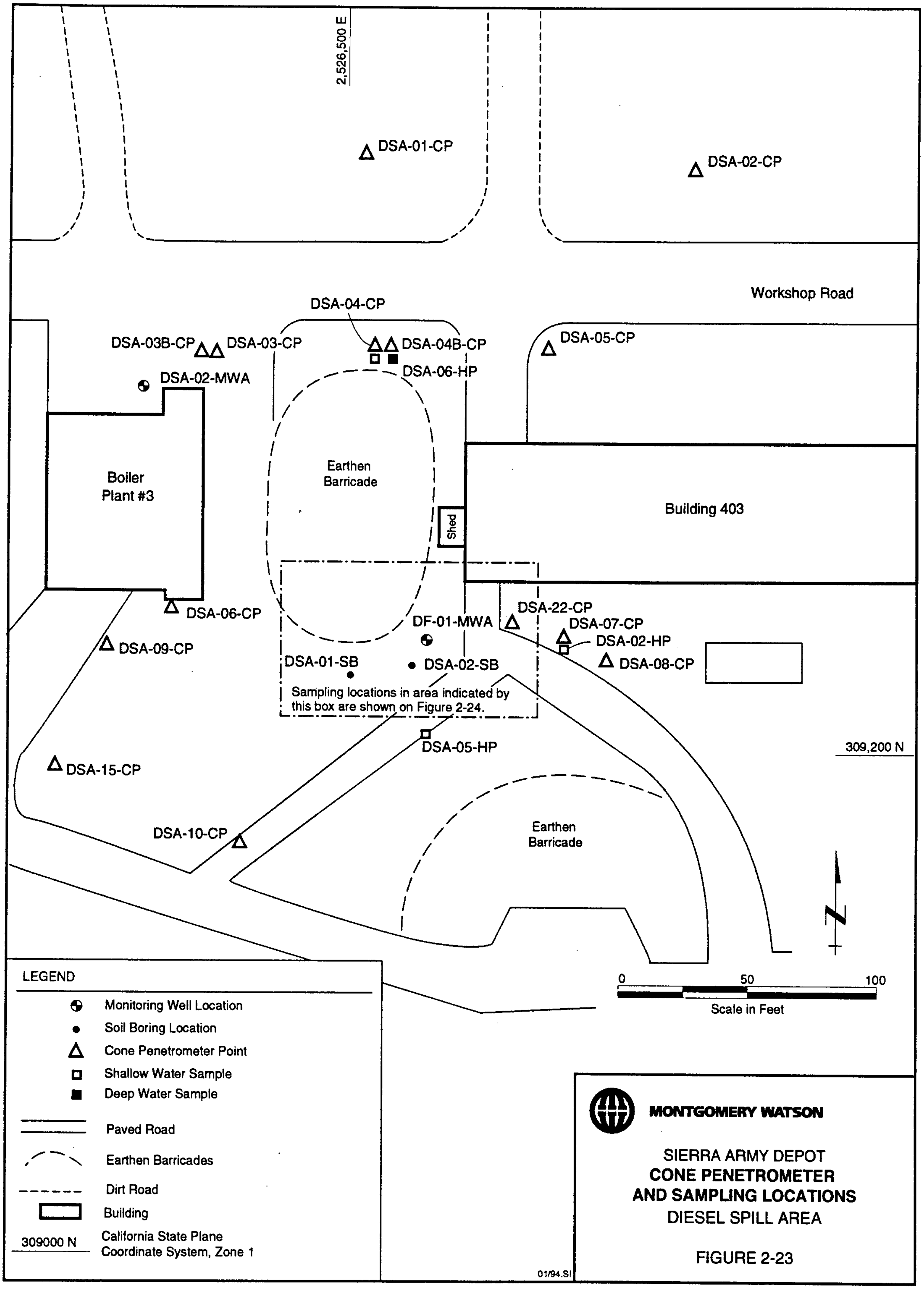
Soil

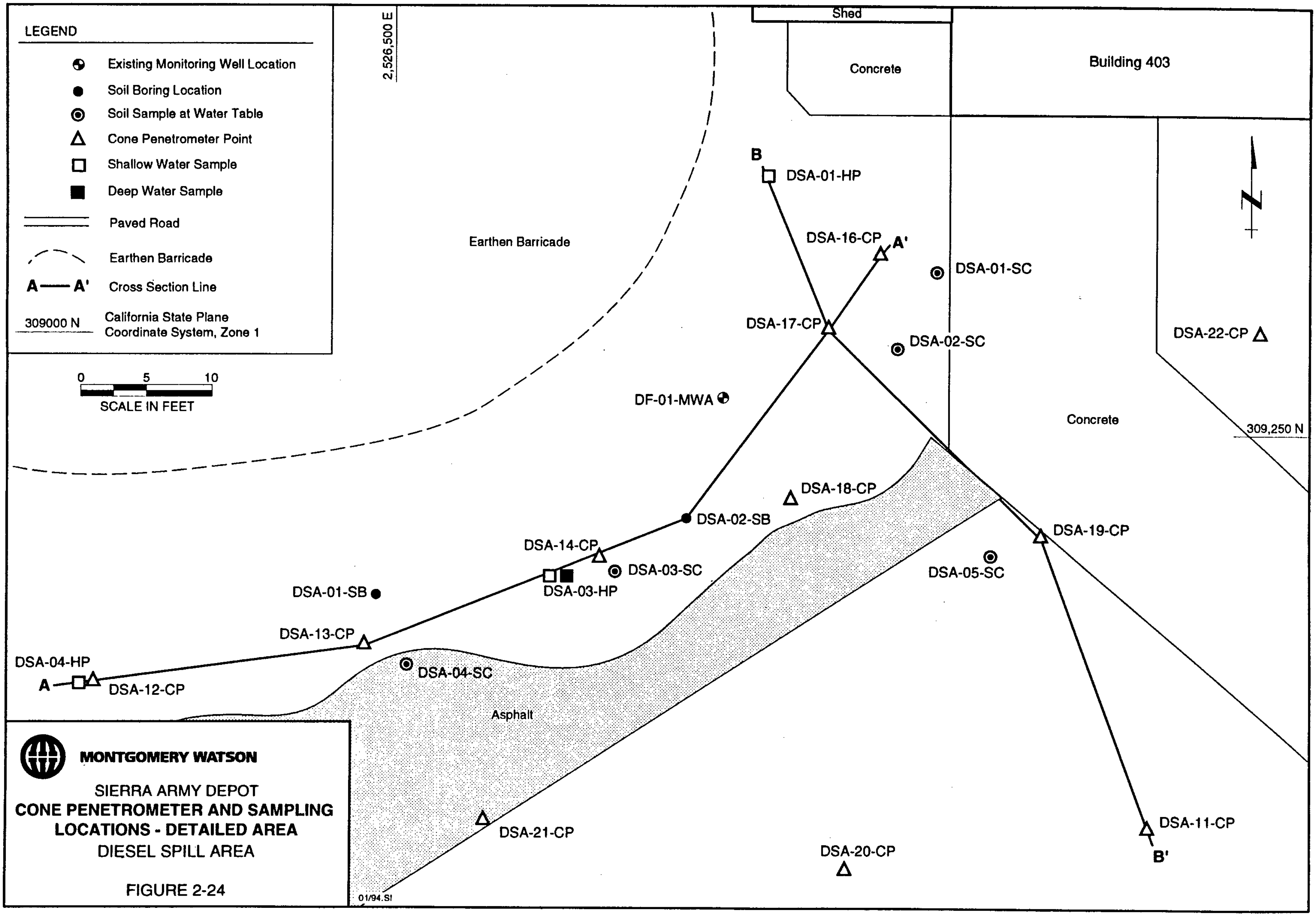
The SCAPS CPT system was used at 22 locations to characterize soil stratigraphy and obtain a relative total petroleum hydrocarbon (TPH) concentration profile through the soil column. The SCAPS CPT system was able to collect continuous cone resistance data to help characterize the soil stratigraphy and also obtained continuous data on the laser-induced fluorescence response in the soil adjacent to the cone. Fluorescence data can be correlated to the concentration of petroleum hydrocarbons in the soil. The sensor was calibrated to TPH-diesel for the investigation at the Diesel Spill Area.

Actual CPT locations are shown on Figures 2-23 and 2-24. At all CPT locations, both soil lithology and chemical data were obtained. The CPT locations extended to depths of up to 68 feet. Groundwater at the Diesel Spill Area is approximately 62 feet bgs. A total of five CPT points were performed within 30 feet of DF-01-MWA to obtain detailed data within the central portion of the fuel spill (Figure 2-24). These data help further characterize the extent of diesel fuel in the vadose zone and to help define the extent of diesel fuel within the capillary zone immediately above the water table. One CPT point (DSA-13-CP) was located adjacent to existing soil boring DSA-01-SB to help provide confirmation of the chemical data obtained by the cone. Additional soil sampling is discussed below.

The results of the SCAPS CPT sampling indicate that soil is contaminated with diesel at four CPT locations. To verify the CPT results, 13 soil samples were collected and analyzed for TPH, polynuclear aromatic hydrocarbons (PAHs), and total recoverable petroleum hydrocarbons (TRPH) by WES. Figure 2-25 presents the areal extent and Figures 2-26 and 2-27 present the vertical extent of TPH in soil based on the CPT data and all available analytical soil data. A summary report describing the SCAPS CPT system and the results of the SCAPS investigation is presented in Montgomery Watson (1994). A more detailed report on the performance of SCAPS at the Diesel Spill Area has been prepared by WES (Lee et al., in press).

The SCAPS CPT system also collected five soil samples (DSA-01-SC through DSA-05-SC) within the potential "smear" zone approximately 0 to 3 feet above and below the water table (Figure 2-24). The objective of the soil sampling was to characterize the extent of diesel fuel within the zone of water table fluctuation where relatively high concentrations of TPH would be present if free product were present or high concentrations of dissolved TPH were present in the groundwater. All five soil samples were analyzed by Environmental Science and Engineering, Inc. (ESE) laboratory for TPH-gasoline and TPH-diesel using modified EPA Method 8015. TPH-gasoline and TPH-diesel were not detected in any of the soil samples (Table 2-7).


2,526,500 E
DSA-01-CP
DSA-02-CP
Workshop Road
DSA-04-CP
DSA-03B-CP
DSA-03-CP
DSA-04B-CP
DSA-05-CP
DSA-06-HP
DSA-02-MWA
Boiler
Plant #3
Earthen
Barricade
Shed
Building 403
DSA-06-CP
DSA-22-CP
DF-01-MWA
DSA-07-CP
DSA-02-HP
DSA-09-CP
DSA-08-CP
DSA-01-SB
DSA-02-SB
Sampling locations in area indicated by
this box are shown on Figure 2-24.
DSA-05-HP
309,200 N
DSA-15-CP
DSA-10-CP
Earthen
Barricade
0
50
100
Scale in Feet
LEGEND
Monitoring Well Location
Soil Boring Location
Cone Penetrometer Point
Shallow Water Sample
Deep Water Sample
Paved Road
Earthen Barricades
Dirt Road
Building
309000 N
California State Plane
Coordinate System, Zone 1
01/94.SI
MONTGOMERY WATSON
SIERRA ARMY DEPOT
CONE PENETROMETER
AND SAMPLING LOCATIONS
DIESEL SPILL AREA
FIGURE 2-23



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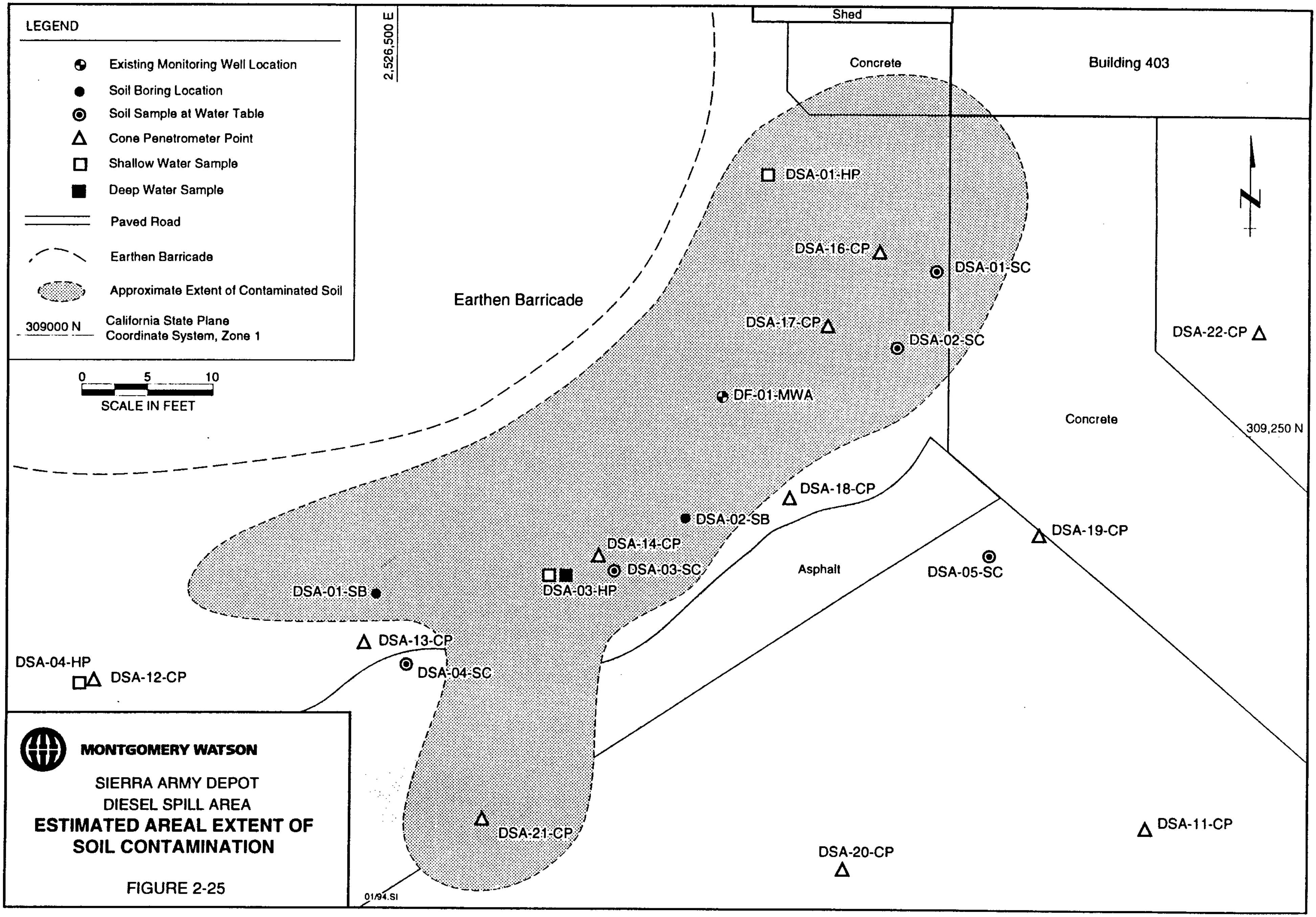
SIERRA ARMY DEPOT
CONE PENETROMETER AND SAMPLING LOCATIONS - DETAILED AREA
DIESEL SPILL AREA

FIGURE 2-24



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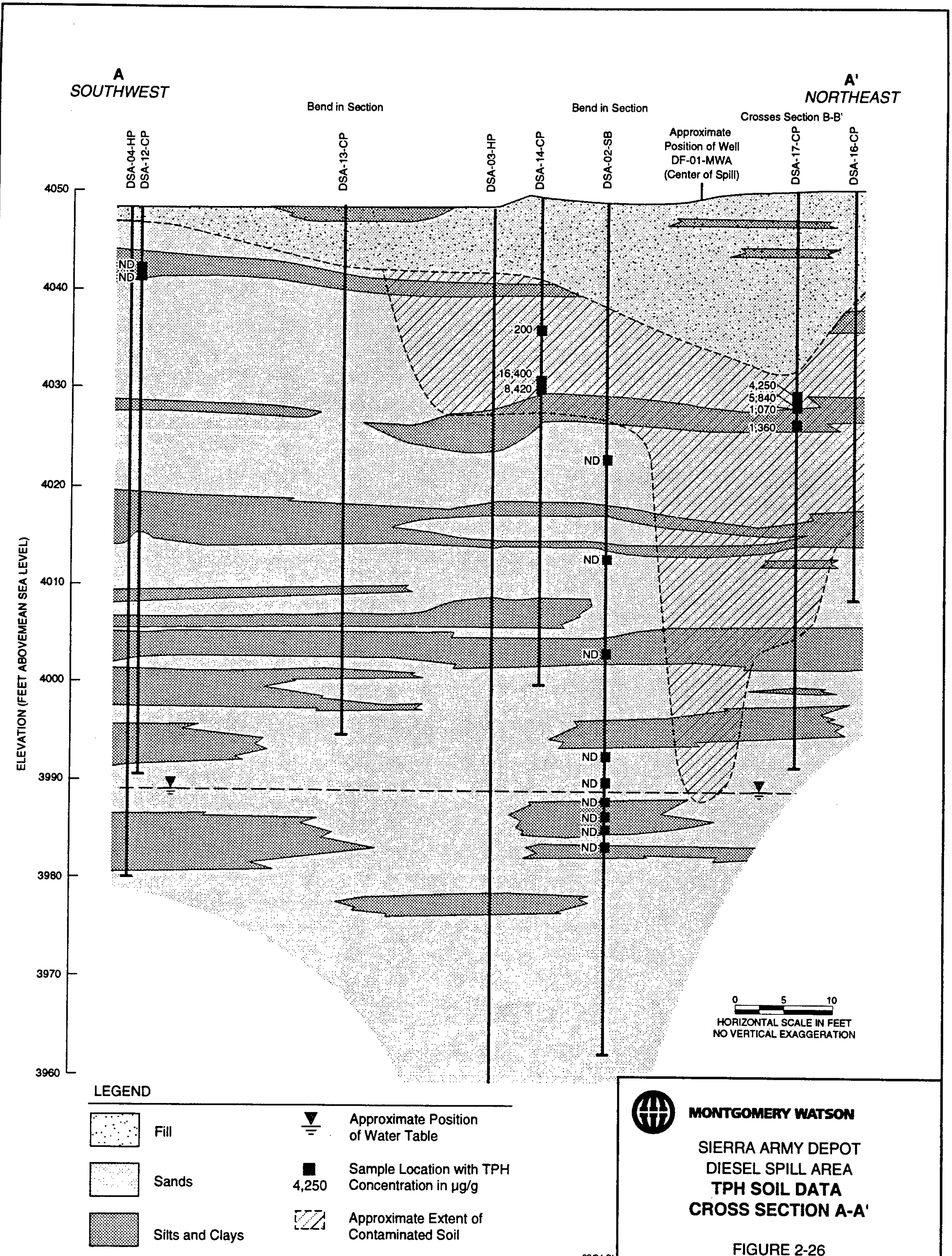
SIERRA ARMY DEPOT
DIESEL SPILL AREA
ESTIMATED AREAL EXTENT OF SOIL CONTAMINATION

FIGURE 2-25



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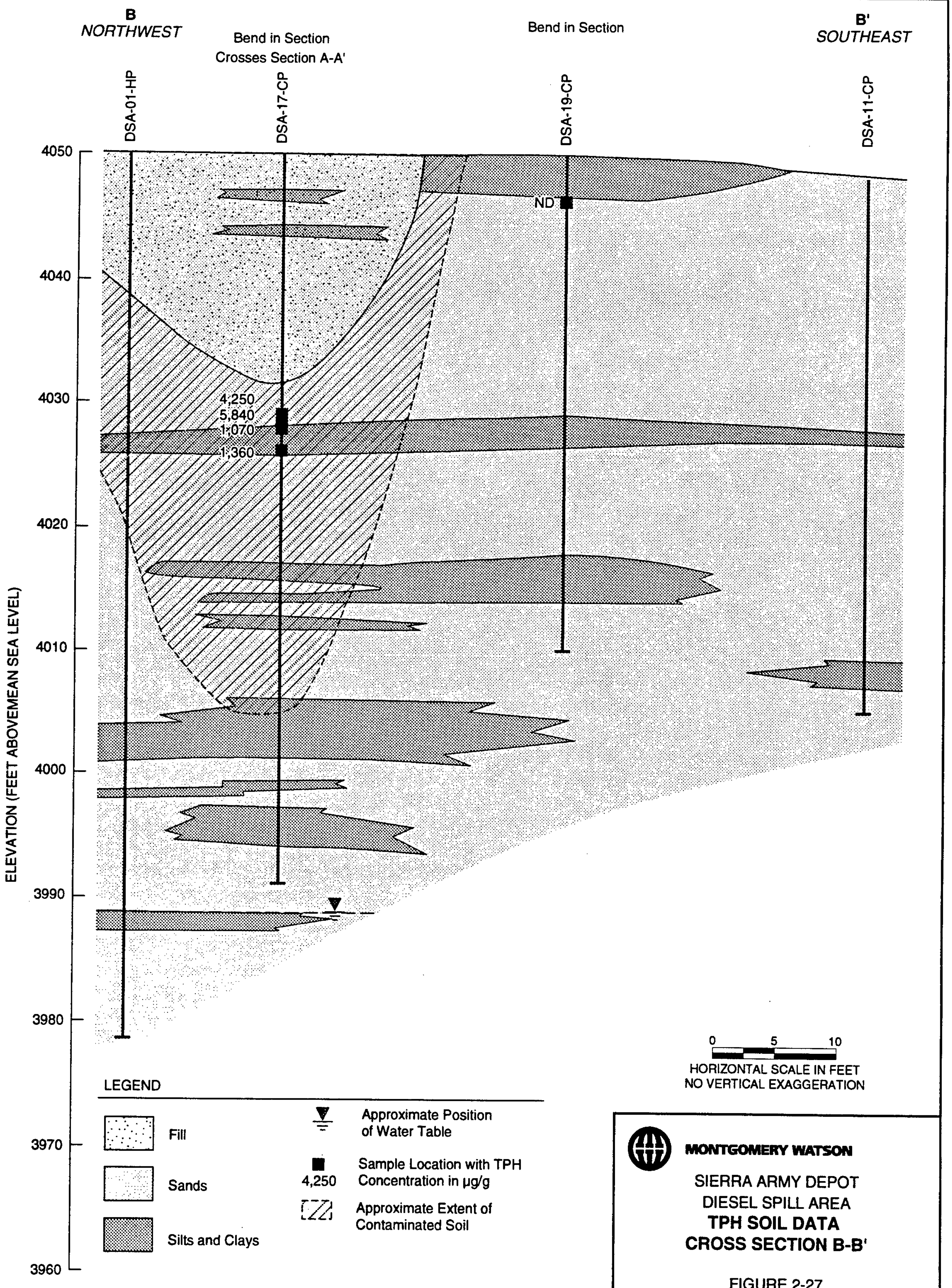
SIERRA ARMY DEPOT
DIESEL SPILL AREA
TPH SOIL DATA
CROSS SECTION A-A'

FIGURE 2-26



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SIERRA ARMY DEPOT
DIESEL SPILL AREA
TPH SOIL DATA
CROSS SECTION B-B'

FIGURE 2-27

TABLE 2-7

SOIL SAMPLE RESULTS
DIESEL SPILL AREA SCAPS INVESTIGATION
(Page 1 of 2)

Sample	Depth (ft)	Sample Date	Compound	Concentration (μg/g)
DSA-02-SB	25	5-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
			Iron	4,270
			Manganese	78.0
	35	5-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
			Iron	5,260
			Manganese	105
	45	5-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
			Iron	8,670
			Manganese	141
	55	5-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
			Iron	9,360
			Manganese	271
	58.5	5-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
	60	5-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
	61.5	5-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
	63	5-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0

TABLE 2-7

SOIL SAMPLE RESULTS
DIESEL SPILL AREA SCAPS INVESTIGATION
(Page 2 of 2)

Sample	Depth (ft)	Sample Date	Compound	Concentration (µg/g)
DSA-02-SB	64.5	5-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
			(a) TOC (9060)	547
			(b) TOC (ASTM)	0.5%
	70	5-Oct-93	(a) TOC (9060)	<431
			(b) TOC (ASTM)	<0.3%
	75	5-Oct-93	(a) TOC (9060)	<405
			(b) TOC (ASTM)	<0.3%
	80	5-Oct-93	(a) TOC (9060)	<486
			(b) TOC (ASTM)	0.5%
	85	5-Oct-93	(a) TOC (9060)	<497
			(b) TOC (ASTM)	1.2%
DSA-01-SC	61.5	11-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
DSA-02-SC	63	12-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
DSA-03-SC	61	12-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
DSA-04-SC	61	13-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0
DSA-05-SC	61	13-Oct-93	TPH-diesel	<21.0
			TPH-gasoline	<21.0

ASTM - American Society of Testing and Materials
TPH - total petroleum hydrocarbons
TOC - total organic carbon
(a) TOC analyzed by EPA Method 9060
(b) TOC analyzed by ASTM Standard Method D 2974

One soil boring (DSA-02-SB) was drilled in the vicinity of DF-01-MWA using a conventional hollow stem auger drill rig and standard split-spoon sampling (Figure 2-25). Soil samples were collected at depths of 25-, 35-, 45-, 55-, 58.5-, 60-, 61.5-, 63-, and 65-feet bgs and analyzed by ESE for TPH-gasoline and TPH-diesel. TPH-gasoline and TPH-diesel were not detected in any of the DSA-02-SB soil samples (Table 2-7).

Four soil samples were collected below the water table and analyzed for total organic carbon (TOC). TOC was only detected in the sample collected from the 65-foot interval of DSA-02-SB (547 mg/kg).

Soil samples collected from the 25-, 35-, 45-, and 55-foot intervals of DSA-02-SB were also analyzed for Microtox bioassay and bacterial plate counts. Bacterial plate counts and Microtox bioassays were performed to assess the quantity and viability of microorganisms indigenous to the site. Specific agars were used for the plate counts to enumerate hydrocarbon-degrading bacteria. In conjunction with the plate counts, the Microtox bioassay results can help determine if toxic conditions exist in the soil matrix that may inhibit biodegradation. The Microtox bioassay is an aqueous general toxicity assay that measures the reduction in light output produced by a suspension of marine luminescent bacteria in response to an environmental sample.

The Microtox results for the 25-foot sample indicate that soil conditions at this location are potentially toxic to hydrocarbon-degrading bacteria. The bacterial plate count results for the 25- and 35-foot soil samples from DSA-02-SB were 710,000 colony-forming units per gram (CFU/g) and 272,500 CFU/g, respectively. Plate counts for the 35- and 45-foot samples from the same boring were less than 300 CFU/g. Typical microbial counts for uncontaminated soil range from 10^6 to 10^7 CFU/g. Since the Microtox results indicate that the soil is generally nontoxic, the low plate count results for the Diesel Spill Area may be attributed to factors other than toxicity such as low moisture content, low organic carbon content, and/or insufficient nutrient levels.

Groundwater. It was originally intended that groundwater samples would be obtained by SCAPS using a HydroPunch sampling system. However, due to high soil resistance, the SCAPS CPT rig was unable to advance the HydroPunch sampling system below the groundwater table (approximately 62 feet bgs). Therefore, groundwater samples were collected using a standard drill rig and a HydroPunch groundwater sampler. A total of six shallow groundwater samples (approximately 5 feet below the water table) were collected (Figures 2-23 and 2-24). In addition, two HydroPunch groundwater samples were collected approximately 30 feet below the water table to characterize the vertical extent of dissolved diesel fuel (Figures 2-23 and 2-24). All groundwater samples were analyzed by ESE for TPH-diesel and TPH-gasoline by modified EPA Method 8015, and VOCs by EPA Method 8240. Table 2-8 summarizes analytical results for the groundwater samples.

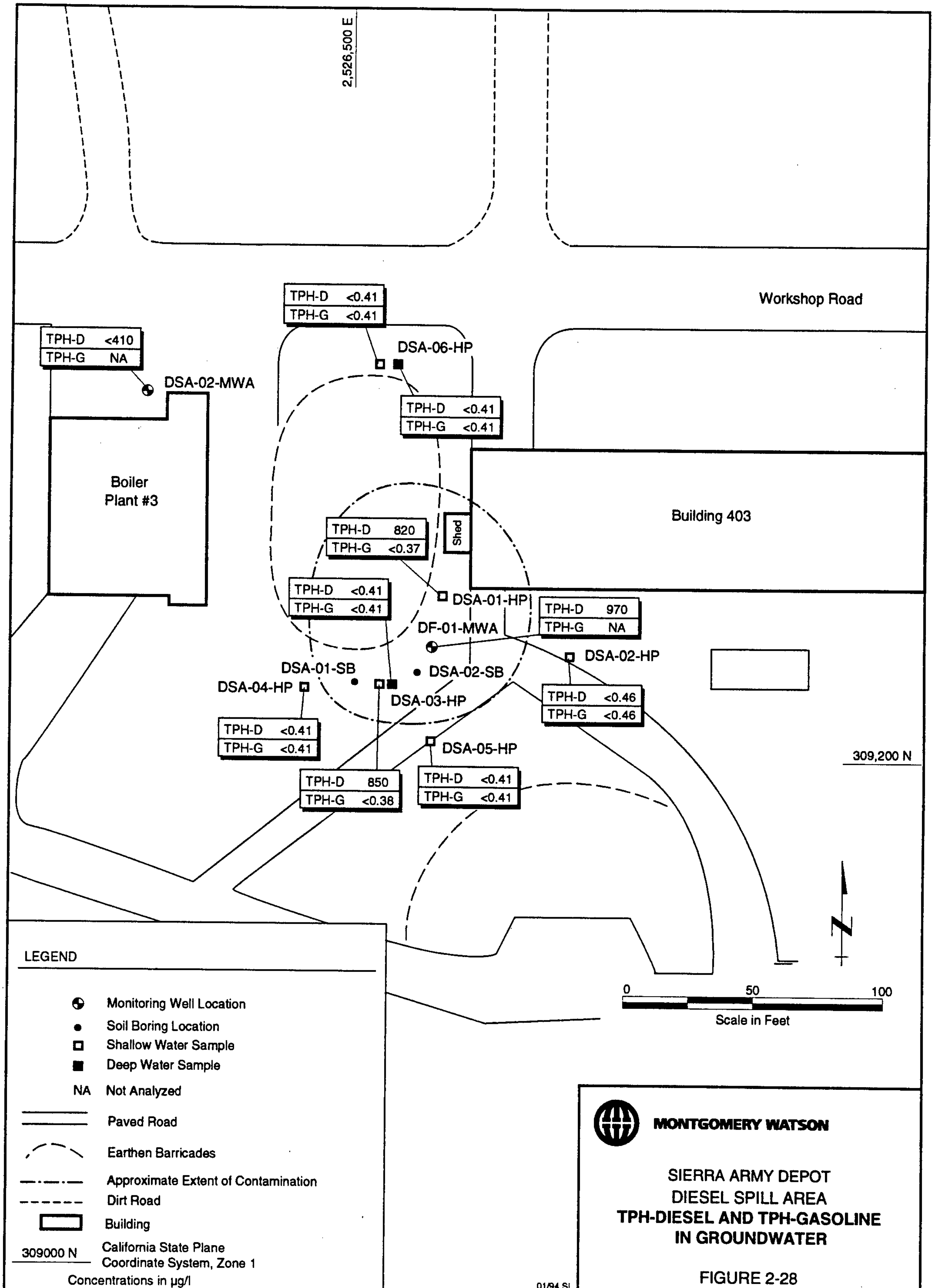
As shown on Figure 2-28, TPH-diesel was detected at 820 μg/l and 850 μg/l in DSA-01-HP and DSA-03-HP (shallow), respectively, but not in any of the other HydroPunch samples. TPH-gasoline was not detected in any of the HydroPunch samples collected. Acetone was detected at 16 μg/l in DSA-02-HP and 14 μg/l in DSA-04-HP. Xylenes were detected at 1.0 μg/l in DSA-03-HP (shallow). Chloroform was detected in three samples: DSA-04-HP

TABLE 2-8

HYDROPUNCH SAMPLE RESULTS
DIESEL SPILL AREA SCAPS INVESTIGATION

SITE	Depth (ft)	Sample Date	Compound	Concentration ($\mu g/l$)
DSA-01-HP	65	18-Nov-93	TPH-diesel	820
			TPH-gasoline	<0.37
			VOCs	ND
DSA-02-HP	70	18-Nov-93	TPH-diesel	<0.46
			TPH-gasoline	<0.46
			Acetone	16
DSA-03-HP	65	20-Nov-93	TPH-diesel	850
			TPH-gasoline	<0.38
			Xylenes	1.0
DSA-03-HP	93	22-Nov-93	TPH-diesel	<0.41
			TPH-gasoline	<0.41
			VOCs	ND
DSA-04-HP	65	23-Nov-93	TPH-diesel	<0.41
			TPH-gasoline	<0.41
			Acetone	14
			Chloroform	0.74
			Trichloroethene	7.75
			Trichlorofluoroethane	2.2
DSA-05-HP	65	22-Nov-93	TPH-diesel	<0.41
			TPH-gasoline	<0.41
			Chloroform	1.7 UJ
			Trichloroethene	6.65
DSA-06-HP	65	23-Nov-93	TPH-diesel	<0.41
			TPH-gasoline	<0.41
			Chloroform	0.83
			Trichloroethene	8.17
DSA-06-HP	93	23-Nov-93	TPH-diesel	<0.41
			TPH-gasoline	<0.41
			Trichloroethene	1.41

UJ - Estimated as non-detect due to detection in associated trip blank sample.



SIERRA ARMY DEPOT
DIESEL SPILL AREA
TPH-DIESEL AND TPH-GASOLINE IN GROUNDWATER

FIGURE 2-28

(0.74μg/l), DSA-05-HP (1.7 μg/l), and DSA-06-HP (shallow) (0.83 μg/l). TCE was detected in four HydroPunch samples: DSA-04-HP (7.75 μg/l), DSA-05-HP (6.65 μg/l), DSA-06-HP (shallow) (8.17 μg/l), and DSA-06-HP (deep) (1.41 μg/l). Trichlorofluoromethane was detected in only one sample (DSA-04-HP) at 2.2 μg/l. Acetone and trichlorofluoromethane are suspected lab contaminants. Figure 2-29 shows the locations of VOCs detections.

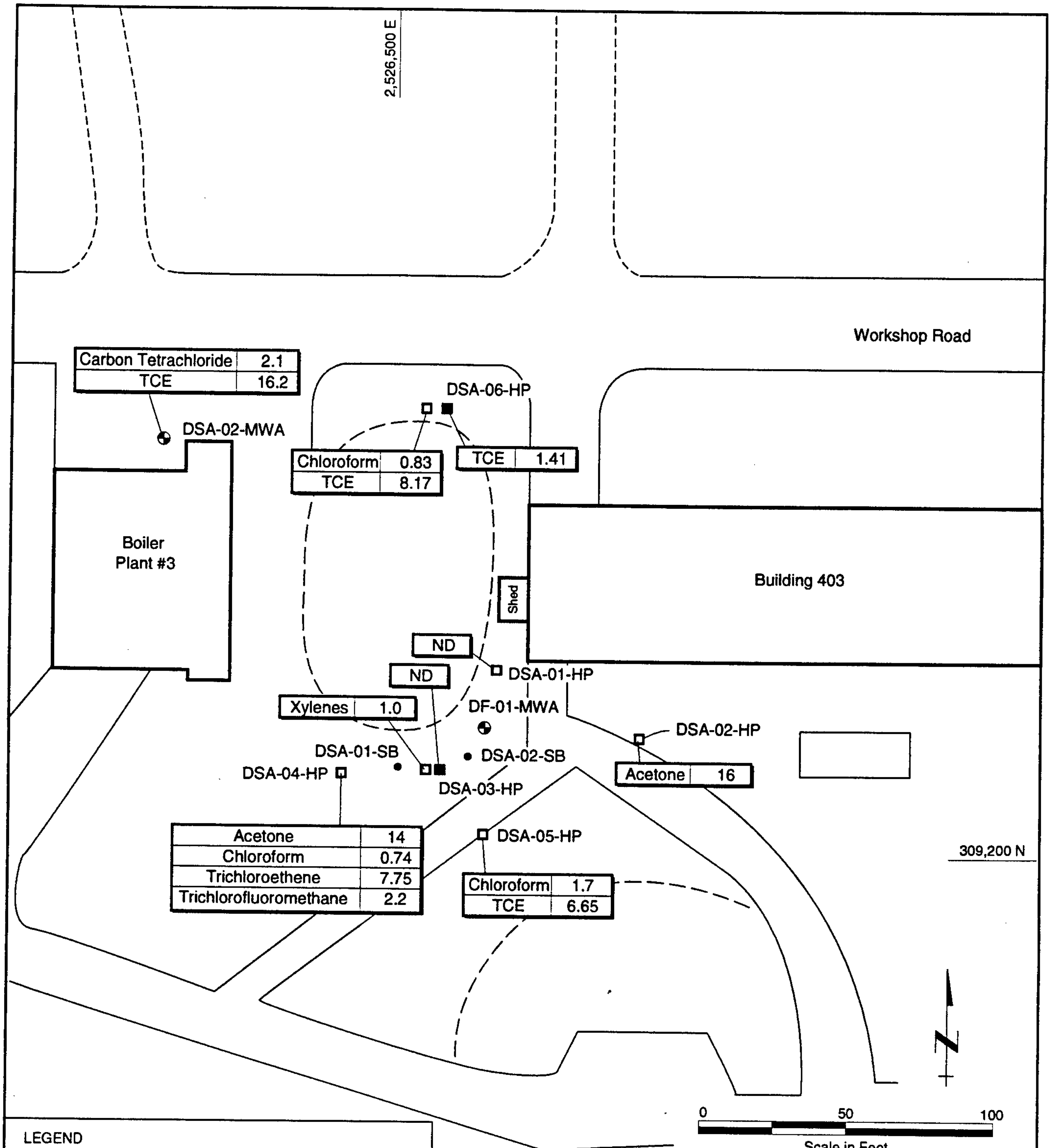
2.5.3.3 Diesel Spill Area Summary. Soil contamination at the Diesel Spill Area is currently defined by two soil borings, 22 SCAPS cone penetrometer points, and five soil samples collected from the "smear" zone above the water table. During the drilling of DSA-01-SB in 1991, elevated levels of TPH-diesel were observed from 15 feet to 35 feet bgs, with the maximum TPH-diesel concentration detected at 20 feet. TPH-diesel was not detected in the DSA-02-SB soil samples or the five "smear" zone samples collected in 1993. Diesel-contaminated soil was observed at four CPT locations. Based on the results of soil sampling at the site, the extent of diesel contamination in soil appears to be limited to the approximate area shown in Figure 2-25. Figure 2-26 is a cross section showing the vertical extent of diesel fuel contamination in soil along the approximate axis of the previous soil excavation and parallel to the former leaking pipe. Figure 2-27 shows the extent of soil contamination transverse to the previous soil excavation and removed piping.

Groundwater contamination at the Diesel Spill Area is currently defined by two monitoring wells (DF-01-MWA and DSA-02-MWA) and eight HydroPunch samples. Elevated levels of TPH-diesel have been observed in DF-01-MWA, which is located near the center of the diesel spill area. TPH-diesel was detected at 970 μg/l in the most recent (1992) sample collected from DF-01-MWA. This well had measurable product during three rounds of sampling (1991 through 1992). However, TPH-diesel has not been detected in surrounding soil samples collected within the zone of water table fluctuation, indicating that the extent of free product above the water table is expected to be limited to a zone of a few feet around DF-01-MWA. During the 1993 SCAPS investigation, TPH-diesel was detected in two of the eight HydroPunch samples: DSA-01-HP (820 μg/l) and DSA-03-HP (shallow) (850 μg/l). Based on groundwater sampling conducted to date at the Diesel Spill Area, the approximate areal extent of groundwater contamination is shown in Figure 2-28.

Several VOCs that are not components of diesel fuel were observed in DSA-02-MWA in 1991 and 1992 and in six of eight HydroPunch samples in 1993 (Figure 2-29). The source of the VOCs in DSA-02-MWA and the HydroPunch samples is believed to be the Paint Shop Site at the TNT Leaching Beds Area northwest of DSA-02-MWA (Figure 2-3).

2.5.4 Old Fire-Fighting Training Facility

Contamination from petroleum hydrocarbons was suspected at this site on the basis of possible use as a fire-fighting training facility in the early 1960s. Potential contamination at the Old Fire-Fighting Training Facility was evaluated on the basis of soil gas data, surface soil, and subsurface soil analytical data. An assessment of potential contamination at the site based on these data is provided in the following subsections.



LEGEND

- Monitoring Well Location
- Soil Boring Location
- Shallow Water Sample
- Deep Water Sample
- Paved Road
- Earthen Barricades
- Dirt Road
- Building
- 309000 N California State Plane Coordinate System, Zone 1

Concentrations in µg/l

01/94.SI

MONTGOMERY WATSON

SIERRA ARMY DEPOT
DIESEL SPILL AREA
VOCs IN GROUNDWATER

FIGURE 2-29

2.5.4.1 Soil Gas. Fifty soil gas samples were collected at the Old Fire-Fighting Training Facility (Figure 2-30) and analyzed for total volatile hydrocarbons (TVHs). A summary of soil gas analytical results for the site is presented in Table 2-9. The analytical results for these soil gas analyses were below quantitation limits and did not indicate the presence of potential organic compound contamination.

2.5.4.2 Surface Soil. Surface soil contamination at the Old Fire-Fighting Training Facility was assessed on the basis of one surface soil sample collected from the surface to the 0.5-foot interval of soil boring OFT-2-SB (Figure 2-30). This sample was collected in soil beneath an asphalt pad at the site. The soil sample was analyzed for target analyte list (TAL) metals, purgeable organics, and TPH.

Table 2-10 presents a summary of the analytical results for TAL metals detected in the surface soil sample at concentrations greater than background concentrations for the soil type 312, Zorravista sandy loam, and type 313, Incy fine sand. The concentration of lead and cobalt in surface soil collected from OFT-2-SB exceeded background concentrations. Field reconnaissance and SIAD staff interviews (O. Bill, T. Totten, and E. Wood, oral commun., 1992) provided no documentation that Army activities at this site would have resulted in elevated levels of inorganic compounds.

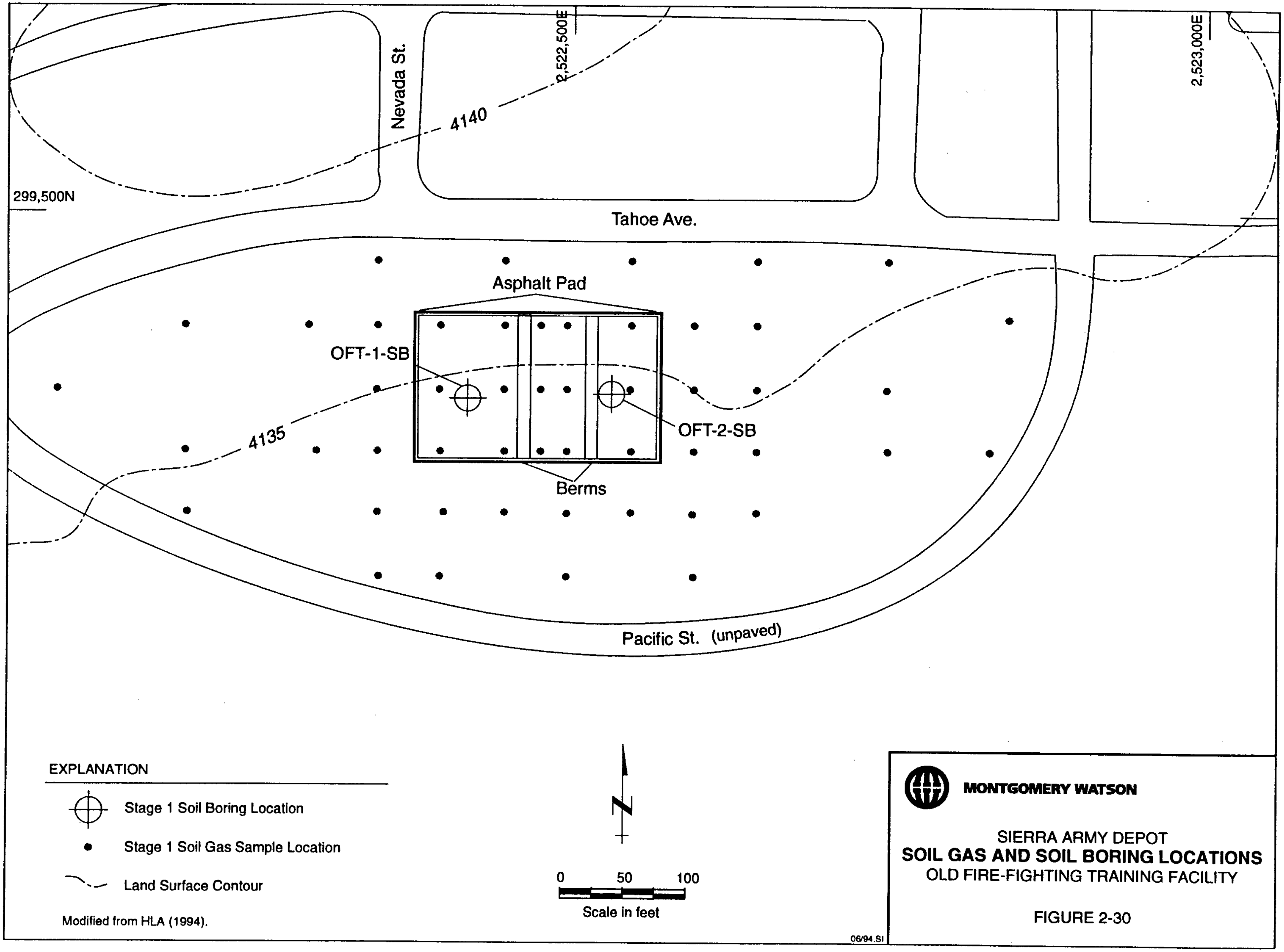
Methylene chloride was the only VOC detected in the surface to the 0.5-foot depth interval of soil boring OFT-2-SB, at a concentration of 161 micrograms per kilogram (mg/kg). Of the 15 surface and surface soil samples collected from the Old Fire-Fighting Training Facility, this was the only sample that contained methylene chloride. This solvent is a common laboratory contaminant that may have been introduced into the sample during sample preparation.

2.5.4.3 Subsurface Soil. Subsurface soil contamination at the Old Fire-Fighting Training Facility was assessed on the basis of 14 subsurface soil samples collected from two soil borings (Figure 2-30). The samples were analyzed for TAL metals, purgeable organics, and TPHs. Purgeable organics and TPHs were not detected in the samples analyzed.

Table 2-11 presents a summary of the analytical results for TAL metals detected in subsurface soil samples at concentrations exceeding background concentrations for subsurface soils consisting predominantly of sand. As indicated in Table 2-11, the concentration of several analytes in the subsurface soil exceeded background levels.

The majority of metal concentrations exceeding background levels were found in subsurface soil samples collected from depths greater than 6 feet. The relatively low mobility of metals in unsaturated subsurface soil indicates that the analyte concentrations for these subsurface soil samples may represent natural conditions.

As indicated in Table 2-11, the detected concentration of arsenic in subsurface soil at the site that exceed background concentrations was qualified denoting that the analytical data may be biased high. The apparent bias in the data is supported by the sporadic occurrence of the elevated arsenic values and by the lack of a source for arsenic contamination.



SIERRA ARMY DEPOT
SOIL GAS AND SOIL BORING LOCATIONS
OLD FIRE-FIGHTING TRAINING FACILITY

FIGURE 2-30

TABLE 2-9

SUMMARY OF SOIL GAS SAMPLING
OLD FIRE-FIGHTING TRAINING FACILITY, NIKE MISSILE FUEL DISPOSAL SITES A AND B

	Old Fire-Fighting Training Facility (50 Samples)				Nike Missile Fuel Disposal Site A (94 Samples)				Nike Missile Fuel Disposal Site B (100 Samples)			
Compound[a]	Number of Samples With Detections	Min Conc (μg/l)	Max Conc (μg/l)	Sample(s) With Max Conc	Number of Samples With Detections	Min Conc (μg/l)	Max Conc (μg/l)	Sample(s) With Max Conc	Number of Samples With Detections	Min Conc (μg/l)	Max Conc (μg/l)	Sample(s) With Max Conc
Methylene chloride	-	-	-	-	0	NA	NA	NA	0	NA	NA	NA
Chloroform	-	-	-	-	12	0.0007	0.01	FDA-22-SG	32	0.0008	0.08	FDB-55-SG
1,2-Dichloroethane	-	-	-	-	0	NA	NA	NA	0	NA	NA	NA
1,1,1-Trichloroethane	-	-	-	-	0	NA	NA	NA	2	0.006	0.007	FDB-89-SG
Carbon tetrachloride	-	-	-	-	21	0.0002	0.0005	FDA-93-SG	1	0.0001	0.005	FDB-88-SG
Trichloroethene	-	-	-	-	2	0.004	0.01	FDA-52-SG	0	NA	NA	NA
Tetrachloroethene	-	-	-	-	8	0.001	0.02	FDA-65-SG	9	0.0007	0.006	FDB-57-SG
Benzene	-	-	-	-	9	0.03	0.5	FDA-72-SG	3	0.05	0.4	FDB-64-SG
Toluene	-	-	-	-	1	NA	0.2	FDA-72-SG	0	NA	NA	NA
Ethylbenzene	-	-	-	-	0	NA	NA	NA	0	NA	NA	NA
Xylenes	-	-	-	-	0	NA	NA	NA	0	NA	NA	NA
Total volatile hydrocarbons	0	NA	NA	NA	4	0.3	2	FDA-72-SG	10	0.1	0.5	FDB-41-SG

Site identifications were labeled sequentially.
[a] Compounds are listed in elution order.

\- = not analyzed
μg/l = micrograms per liter
Conc = concentration
Max = maximum
Min = minimum
NA = not applicable

TABLE 2-10

SUMMARY OF METAL CONCENTRATIONS IN SURFACE SOIL THAT ARE GREATER THAN BACKGROUND CONCENTRATIONS
OLD FIRE-FIGHTING TRAINING FACILITY

Analyte	Minimum[a] Background Concentration (mg/kg)	Maximum[a] Background Concentration (mg/kg)	OFT-2-SB (0.0 to 0.5 feet)
Cobalt	2.73	2.86	6.7
Lead	0.170	7.96	13
Nickel[b]	2.62	12.6	8.7

[a] Minimum and maximum concentrations for background surface soil types 312 and 313 taken from Table 5.3, Draft Final Remedial Investigation for Sierra Army Depot-Group III A Sites (HLA, 1994).
[b] Although nickel is not detected at levels above background, it remains listed in this table because it was evaluated in the Remedial Investigation for Sierra Army Depot-Group III A Sites (HLA, 1994).

mg/kg = milligrams per kilogram

TABLE 2-11

SUMMARY OF METAL CONCENTRATIONS IN SUBSURFACE SOIL THAT ARE GREATER THAN BACKGROUND CONCENTRATIONS
OLD FIRE-FIGHTING TRAINING FACILITY

	Maximum Background Concentration		OFT-1-SB	OFT-1-SB	OFT-1-SB	OFT-1-SB	OFT-2-SB	OFT-2-SB	OFT-2-SB
Depth (feet):			5.5	10.5 to 11.5[c]	40.5	50.5	5.5 to 6.0[c]	10.5	50.5
Sample Date:			08/21/92	08/21/92	08/21/92	08/21/92	08/22/92	08/22/92	08/22/92
Soil Type:	Sand[a]	Silt/Clay[b]	SP	SP	SP	SW	SP	SP	SM
Analytes (mg/kg)									
Aluminum	7,895	28,000	-	-	-	-	-	-	-
Arsenic	18.0	7.14	-	46(7)	-	-	-	-	-
Barium	217	630	-	262	-	-	-	-	-
Calcium	16,640	54,900	-	-	-	-	-	-	-
Chromium	12.7	31.0	-	-	-	-	-	-	-
Cobalt	15.0	15.0	-	-	-	-	-	-	-
Iron	12,900	27,900	-	14,900	15,000	-	-	-	13,600
Magnesium	5,835	26,600	-	5,965	-	-	-	-	-
Manganese	366	707	456	465	-	-	-	-	495
Nickel	12.6	22.4	-	-	-	-	-	-	-
Potassium	4,315	8,200	-	5,070	-	-	-	-	-
Vanadium	52.7	130	-	-	-	-	-	-	-
Zinc	63.5	84.2	-	-	-	-	-	-	-

[a] Maximum concentrations for background subsurface sandy soil taken from Table 5.9, Draft Final Remedial Investigation for Sierra Army Depot-Group III A Sites (HLA, 1994)

[b] Maximum concentrations for background silt and clay soil taken from Table 5.8, Draft Final Remedial Investigation for Sierra Army Depot-Group III A Sites (HLA, 1994)

[c] Average of duplicate sample analyses

(7) = sample spike criteria for this analyte were not within limits specified for the analytical method. Data are acceptable as flagged; however, they may be potentially biased.

- = analyte not detected at levels exceeding background

mg/kg = milligrams per kilogram

SM = silty sand

SP = poorly graded sand

SW = well-graded sand

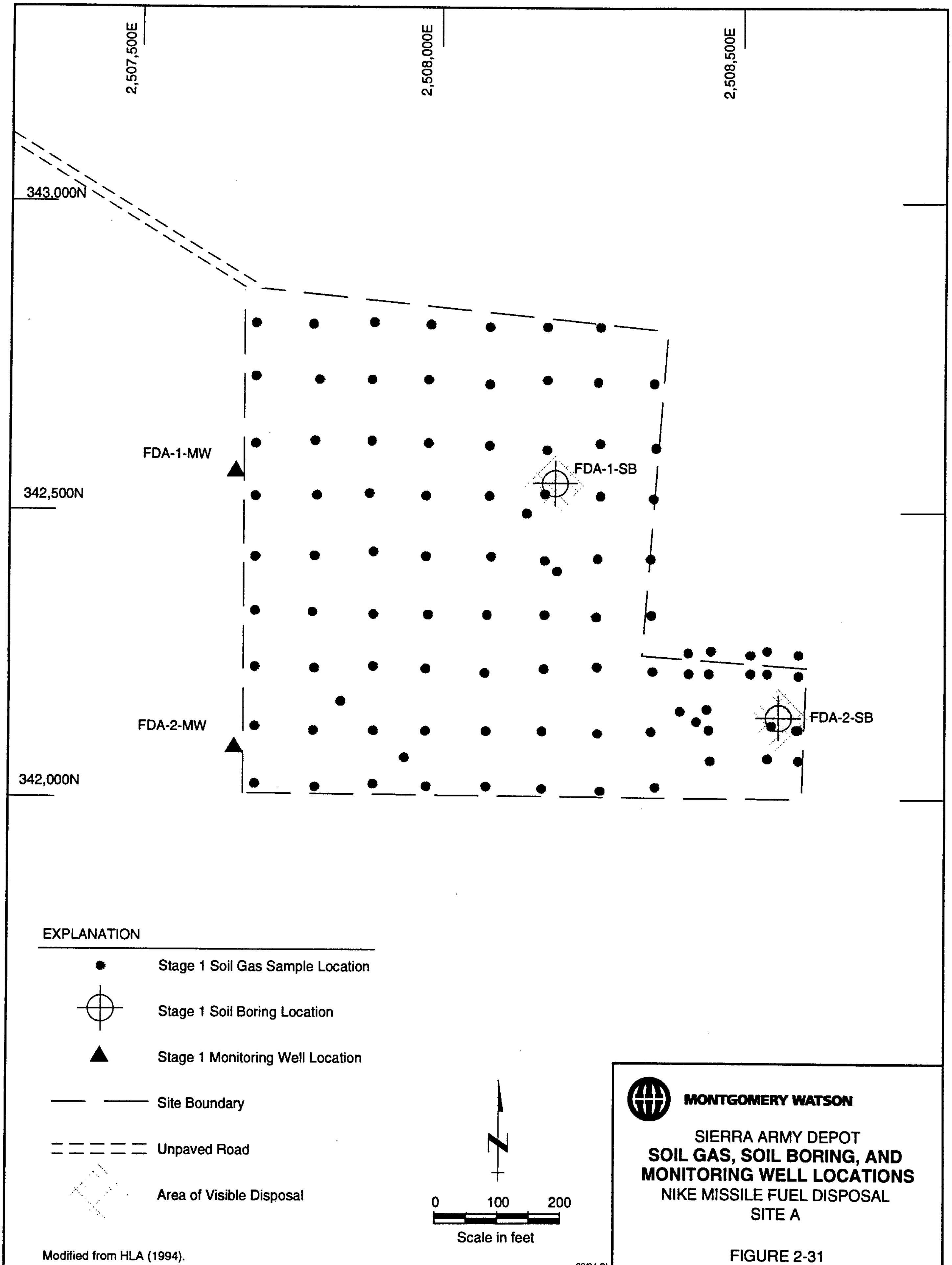
2.5.5 Nike Missile Fuel Disposal Site A

Contamination at this site was suspected on the basis of past activities at this site that included burning aviation fuel (JP-4) and evaporating inhibited red-fuming nitric acid (IRFNA). Potential contamination at the Nike Missile Fuel Disposal Site A was evaluated on the basis of soil-gas data, surface and subsurface soil analytical data, and groundwater analytical data. An assessment of potential contamination at the site based on these data is provided in the following subsections.

2.5.5.1 Soil Gas. Ninety-four soil-gas samples were collected at the Nike Missile Fuel Disposal Site A (Figure 2-31) and analyzed for selected VOCs and total volatile hydrocarbons (TVHs). Soil-gas analytical results (Table 2-9) indicated that organic compounds including chloroform, carbon tetrachloride, trichloroethane, toluene, tetrachloroethane, and benzene were detected at low concentrations in soil-gas samples. The highest concentrations of benzene, toluene, and TVHs were detected in samples collected from soil-gas sampling site FDA-72-SG. Because soil-gas screening was used to assess possible subsurface soil or groundwater contamination, a soil boring (FDA-2-SB) was installed near soil-gas sampling point FDA-72-SG to further investigate possible subsurface contamination. The results from this boring are discussed in Section 2.5.5.3. The concentrations and distribution of soil gas analytes at other Nike Missile Fuel Disposal Site A soil-gas locations were sporadic and did not indicate sources of organic compound contamination warranting additional investigation. This assessment was confirmed by the analytical results of the surface and subsurface soil samples as discussed below.

2.5.5.2 Surface Soil. Surface soil contamination at the Nike Missile Fuel Disposal Site A was assessed on the basis of samples collected from the surface to 0.5-foot interval in two soil borings (FDA-1-SB and FDA-2-SB) (Figure 2-31). The surface soil samples were analyzed for purgeable organics, TPH, and nitrate plus nitrite-N (reported as a single value). In addition, two discrete surface soil samples (FDA-1-SS and FDA-2-SS) were collected from an area adjacent to each boring and analyzed for herbicides. Purgeable organics, TPH, and herbicides were not detected in the surface soil samples at concentrations above the certified reporting limit (CRL). Nitrate plus nitrite-N was the only analyte detected in surface soil collected from the site. The nitrate plus nitrite-N concentrations in FDA-1-SB and FDA-2-SB surface soil were 60 and 5.62 mg/kg, respectively. Background SIAD surface soil concentrations (surface soil type 356, Honlak sandy loam) for nitrate plus nitrite-N are not available for comparison with the investigative samples. However, nitrate plus nitrite-N levels within two soil borings that appear to be indicative of background conditions (FDA-2-SB and FDB-3-SB) are found to be less than 10 mg/kg in 11 of 12 samples analyzed. This observation may indicate that the higher concentration of nitrate plus nitrite-N at FDA-1-SB could be related to a source of these compounds (such as IRFNA) in the vicinity of the boring. This assessment is consistent with the observation that boring FDA-1-SB was located near metal dishes that were reportedly used for the disposing IRFNA.

2.5.5.3 Subsurface Soil. Subsurface soil contamination at the Nike Missile Fuel Disposal Site A was assessed on the basis of 10 subsurface soil samples collected from two soil borings (Figure 2-31). Subsurface soil samples collected from each boring were analyzed for purgeable


2,507,500E
2,508,000E
2,508,500E
343,000N
342,500N
342,000N
FDA-1-MW
FDA-1-SB
FDA-2-MW
FDA-2-SB
EXPLANATION
Stage 1 Soil Gas Sample Location
Stage 1 Soil Boring Location
Stage 1 Monitoring Well Location
Site Boundary
Unpaved Road
Area of Visible Disposal
Modified from HLA (1994).
0
100
200
Scale in feet
06/94.SI
MONTGOMERY WATSON
SIERRA ARMY DEPOT
SOIL GAS, SOIL BORING, AND
MONITORING WELL LOCATIONS
NIKE MISSILE FUEL DISPOSAL
SITE A
FIGURE 2-31

organics, TPHs, and nitrate plus nitrite-N. Purgeable organics and TPH compounds were not detected in the subsurface soil samples at concentrations above the CRL. Nitrate plus nitrite-N was the only analyte detected in the subsurface soil samples. Table 2-12 presents a summary of nitrate plus nitrite-N concentrations in the subsurface soil collected from this site. As with the surface soil samples discussed in the previous paragraph, the detected nitrate plus nitrite-N levels in boring FDA-1-SB are greater than detected nitrate plus nitrite-N levels in FDA-2-SB. Because the observed concentration is approximately two orders of magnitude greater than concentrations in samples collected from soil boring FDA-2-SB and because boring FDA-1-SB was located near metal disks that were reportedly used for disposing IRFNA, the elevated nitrate plus nitrite-N concentrations may indicate that the process of evaporating IRFNA at the site released nitrates to the soil. Based upon the analytical data presented in Table 2-12, the maximum concentration of nitrate plus nitrite-N is 5,400 mg/kg found in FDA-1-SB at a sample depth of 6.5 feet. The concentration is lower at the 9.5-foot (600 mg/kg) and 12.5-foot (210 mg/kg) sample depths; however, the reported nitrate plus nitrite-N value increases at the 15.5-foot sample depth to 1,500 mg/kg, which is near the top of the water table. The maximum on-site concentrations, however, were below calculated health-based levels and are considered protective of human health and the environment.

2.5.5.4 Groundwater. Potential contamination of groundwater at the Nike Missile Fuel Disposal Site A was assessed on the basis of groundwater collected from two monitoring wells (Figure 2-31) during two rounds of sampling. Samples were analyzed for purgeable organics, nitrate plus nitrite-N, and macroparameters. Purgeable organics were not detected in the groundwater samples at concentrations above the CRL. The concentrations of inorganic analytes in the groundwater samples were less than background groundwater concentrations. The maximum concentration of nitrate plus nitrite-N detected in groundwater collected at this site was 170 μg/l. Based on these results, it appears that the concentrations of nitrate plus nitrite-N in the subsurface soil at FDA-1-SB have not significantly degraded groundwater quality at the monitoring well locations.

Nitrate plus nitrite-N concentrations of 23.9 μg/l to 16.2 μg/l detected in groundwater were below federal MCLs of 10,000 μg/l for nitrate and 1,000 μg/l for nitrite and the California MCL of 45,000 μg/l for nitrate. Additionally, the nitrate plus nitrite-N concentrations were below established federal health advisory concentrations, which mirror federal MCLs.

2.5.6 Nike Missile Fuel Disposal Site B

Similar to Nike Disposal Site A, contamination at this site was suspected on the basis of past activities that included burning JP-4 and evaporating IRFNA. Potential contamination at the Nike Missile Fuel Disposal Site B was evaluated on the basis of soil-gas data, surface and subsurface soil analytical data, and groundwater analytical data. An assessment of potential contamination at the site based on these data is provided in the following subsections.

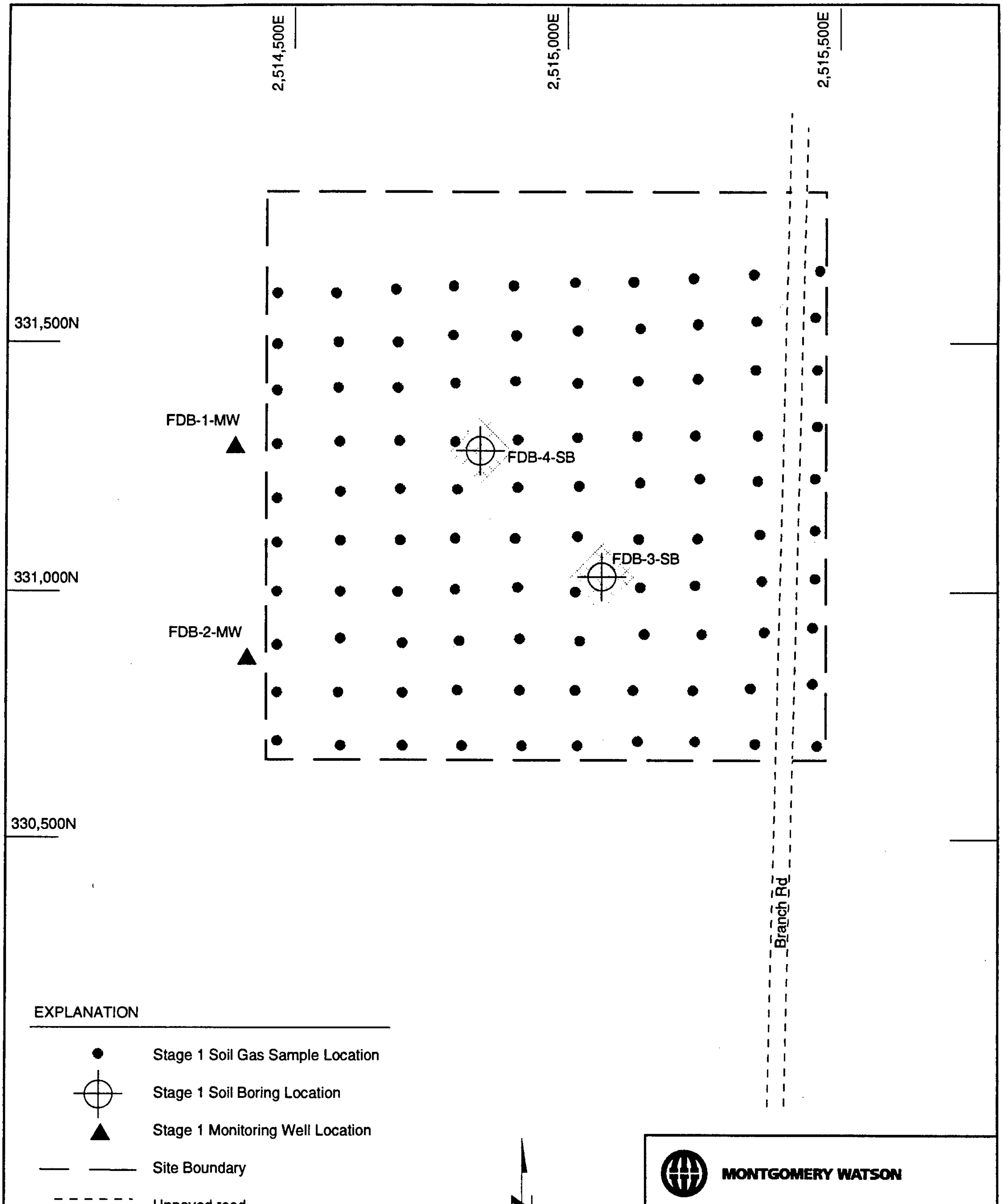
2.5.6.1 Soil Gas. One hundred soil-gas samples were collected at the Nike Missile Fuel Disposal Site B (Figure 2-32) and analyzed for selected volatile organics and TVHs. Soil-gas analytical results (Table 2-9) indicated that organic compounds including chloroform,

TABLE 2-12

SUMMARY OF NITRATE PLUS NITRITE-N CONCENTRATIONS IN SUBSURFACE SOIL NIKE MISSILE FUEL DISPOSAL SITE A

	Nitrate Plus Nitrite as Nitrogen (mg/kg)	
Sample Depth (feet)	FDA-1-SB	FDA-2-SB
3.5	2700	4.6
6.5	5400	1.7
9.5	600	1.2
2.5	210	<0.6
15.5	1500	<0.6

< = less than
mg/kg = milligrams per kilogram



SIERRA ARMY DEPOT
SOIL GAS, SOIL BORING, AND MONITORING WELL LOCATIONS
NIKE MISSILE FUEL DISPOSAL SITE B

FIGURE 2-32

1,1,1-trichloroethane, carbon tetrachloride, tetrachloroethane, and benzene were detected at low concentrations in soil-gas samples collected from the Nike Missile Fuel Disposal Site B.

There is no discernible pattern in the detections and concentrations of soil-gas analytes at the respective Nike Fuel Disposal Site B soil-gas sample collection locations; therefore, these detections and concentrations do not indicate possible subsurface or groundwater sources of organic contamination that warrant additional investigation. This assessment was confirmed by the analytical results of the surface and subsurface soils as discussed below.

2.5.6.2 Surface Soil. Surface soil contamination at the Nike Missile Fuel Disposal Site B was assessed on the basis of samples collected from the surface to 0.5-foot interval of two soil borings (Figure 2-32). The surface soil samples were analyzed for purgeable organics, TPHs, herbicides, and nitrate plus nitrite-N. Purgeable organics and TPHs were not detected in the surface soil sample at concentrations above the CRL. Nitrate plus nitrite-N was the only analyte detected in the surface soil collected from the site. The nitrate plus nitrite-N concentrations in the FDB-3-SB and FDB-4-SB surface soil samples were 34 and 27 mg/kg, respectively. Background SIAD surface soil concentrations for nitrate plus nitrite-N are not available for comparison to investigative samples. However, as discussed in Section 2.5.5.2 (Nike Missile Fuel Disposal Site A), nitrate plus nitrite-N values in soil were typically less than 10 mg/kg. The concentrations reported in the investigative samples that were collected in shallow surface depressions suspected as locations for disposal activities may indicate contamination from evaporating IRFNA.

2.5.6.3 Subsurface Soil. Subsurface soil contamination at the Nike Missile Fuel Disposal Site B was assessed on the basis of 12 subsurface soil samples collected from two soil borings (Figure 2-32). Subsurface soil samples were analyzed for purgeable organics, TPH, and nitrate plus nitrite-N. Purgeable organics and TPH were not detected at concentrations above the CRL in the subsurface soil samples. Nitrate plus nitrite-N was the only analyte detected in the subsurface soil samples. Table 2-13 presents a summary of nitrate plus nitrite-N concentrations in the subsurface soil collected from this site. The nitrate plus nitrite-N concentrations were consistently higher in the subsurface soil samples collected from FDB-4-SB than in the subsurface samples collected from FDB-3-SB. Because the observed concentration is up to two orders of magnitude greater than concentrations in samples collected from FDB-3-SB, the elevated nitrate plus nitrite-N concentrations may indicate that the repeated process of evaporating IRFNA at the site resulted in release of nitrates to the soil.

Based on the analytical data presented in Table 2-13, the concentration of nitrate plus nitrite-N at FDB-4-SB decreases in concentration with increasing sample depth after 6.5 feet. The nitrate plus nitrite-N concentrations were less than 10 mg/kg at both the 18.5-foot and 21.5-foot sample depths.

2.5.6.4 Groundwater. Groundwater contamination at the Nike Missile Fuel Disposal Site B was assessed on the basis of groundwater collected from two monitoring wells (FDB-1-MW and FDB-2-MW) (Figure 2-32) during two rounds of sampling. Samples were analyzed for purgeable organics, nitrate plus nitrite-N, and macroparameters. Purgeable organics were not

TABLE 2-13

SUMMARY OF NITRATE PLUS NITRITE-N CONCENTRATIONS IN SUBSURFACE SOIL NIKE MISSILE FUEL DISPOSAL SITE B

	Nitrate Plus Nitrite as Nitrogen (mg/kg)	
Sample Depth (feet)	FDB-3-SB	FDB-4-SB
3.5	87	660
6.5	3.2	1,700
9.5	8.3	700
2.5	2.2	630
15.5	2.1	500
18.5	1.3	-
21.5	<0.6	-

< = less than
- = not analyzed
mg/kg = milligrams per kilograms

detected in the groundwater samples at concentrations above the CRL. The concentrations of inorganic analytes in the groundwater samples were less than background groundwater analyte concentrations. The maximum concentration of nitrate plus nitrite-N detected in groundwater collected at this site was 300 μg/l. Based on the results of the groundwater analyses, it appears that the concentrations of nitrate plus nitrite-N in the subsurface soil at FDB-4-SB have not significantly degraded groundwater quality at the monitoring well locations.

2.5.7 Toxic Storage Building 578

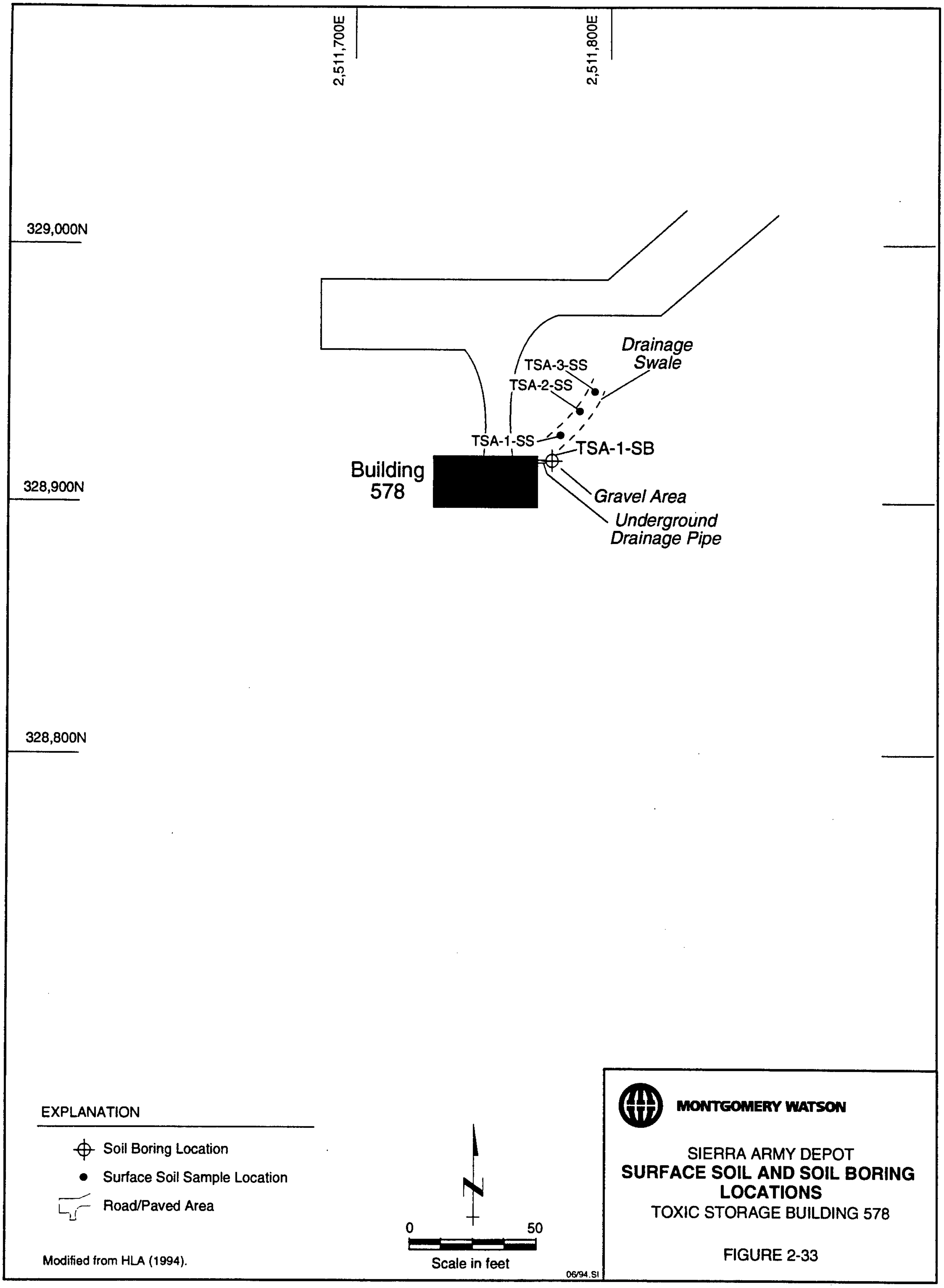
Contamination at this site was suspected on the basis of the purported release of materials that included cyanide compounds. Potential contamination at the Toxic Storage Building 578 was evaluated using surface and subsurface soil analytical data. An assessment of potential contamination at the site based on these data is provided in the following subsections.

2.5.7.1 Surface Soil. Surface soil contamination at the Toxic Storage Building 578 was assessed on the basis of three surface soil samples (Figure 2-33). The surface soil samples were analyzed for target compound list (TCL) SVOCs, TAL metals, and cyanide. TCL SVOCs and cyanide were not detected in the surface soil samples at concentrations above the CRL. Table 2-14 presents a summary of analytes detected in the surface soil samples at concentrations exceeding SIAD background concentrations for the soil type 365, Ardep sandy loam. As shown in Table 2-14, five analytes (aluminum, calcium, iron, magnesium, and sodium) were elevated with respect to the background concentrations. These analyte concentrations are believed to be elevated due to leaching and runoff from non-native materials composing the gravel pad adjacent to Building 578.

2.5.7.2 Subsurface Soil. Subsurface soil contamination at Toxic Storage Building 578 was assessed on the basis of five subsurface soil samples collected from one soil boring (Figure 2-33). Soil samples were analyzed for TCL organics, TAL metals, and cyanide. TCL organic compounds and cyanide were not detected in the subsurface soil samples. Table 2-15 presents a summary of metals detected in the subsurface soil samples at concentrations that exceeded SIAD background metal concentrations for several soil types. The majority of metals exceeding background concentrations are from soil collected from the 3.5-foot depth interval. The soil collected from the 3.5-foot interval is classified as silty sand (SM). Because of the silt component of this sample, the analyte concentrations have been compared to background analyte concentrations in clay and silt soils. Calcium slightly exceeded calculated background values.

2.5.8 Unidentified Pit

Potential contamination of the Unidentified Pit was evaluated on the basis of surface geophysical data and surface soil, subsurface soil, and groundwater analytical data. Contamination was suspected at this site because the use of the pit and its origin were unknown. An assessment of potential contamination at the site based on the analytical data is provided in the following subsections. The geophysical data indicate that there were no anomalies indicative of subsurface disposal or bomb fragments.


2,511,700E
2,511,800E
329,000N
328,900N
328,800N
Drainage Swale
TSA-3-SS
TSA-2-SS
TSA-1-SS
TSA-1-SB
Building 578
Gravel Area
Underground Drainage Pipe
EXPLANATION
Soil Boring Location
Surface Soil Sample Location
Road/Paved Area
Modified from HLA (1994).
0
50
Scale in feet
N
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MONTGOMERY WATSON
SIERRA ARMY DEPOT
SURFACE SOIL AND SOIL BORING LOCATIONS
TOXIC STORAGE BUILDING 578
FIGURE 2-33

TABLE 2-14

SUMMARY OF ANALYTE CONCENTRATIONS IN SURFACE SOIL THAT ARE GREATER THAN BACKGROUND CONCENTRATIONS TOXIC STORAGE BUILDING 578

Analyte	Maximum[a] Background Concentration (mg/kg)	TSA-1-SS[b] 08/25/92	TSA-2-SS 08/25/92	TSA-3-SS 08/25/92
Aluminum	6,710	6,940	8,160	-
Calcium	34,300	46,100	48,900	44,000
Iron	8,440	9,145	10,200	-
Magnesium	4,310	5,805	6,310	-
Sodium	352	-	369	-

[a] Minimum and maximum concentrations for background surface soil type 365 taken from Table 5.6, Draft Final Remedial Investigation for Sierra Army Depot-Group III A Sites (HLA, 1994)

[b] Average of duplicate sample analyses

- = analyte not detected above background levels
mg/kg = milligrams per kilogram

TABLE 2-15

SUMMARY OF DETECTED METAL CONCENTRATIONS
IN SUBSURFACE SOIL THAT ARE GREATER THAN
BACKGROUND CONCENTRATIONS
TOXIC STORAGE BUILDING 578

	Maximum Background Concentrations		TSA-1-SB	TSA-1-SB	TSA-1-SB
Depth (feet):			3.5[c]	9.5	12.5
Sample Date:			08/25/92	08/25/92	08/25/92
Soil Type:	Sand[a]	Clay and Silt[b]	(SM)	(SW/SP)	(CL)
Metals (mg/kg)					
Aluminum	7,895	28,000	9,630	-	16,200
Barium	217	630	263	-	-
Calcium	16,640	54,900	66,500	-	-
Chromium	12.7	31.0	-	-	-
Iron	12,900	27,900	-	-	21,200
Magnesium	5,835	26,600	6,735	-	7,480
Manganese	366	707	-	-	-
Potassium	4,315	8,200	-	-	5,390

[a] Maximum concentrations for background subsurface sandy soil taken from Table 5.9; compared to TSA-1-SB at 3.5 and 9.5 feet bgs, Draft Final Remedial Investigation for Sierra Army Depot-Group III A Sites (HLA, 1994)

[b] Maximum concentrations for background subsurface clay and silt soil taken from Table 5.8; compared to TSA-1-SB at 12.5 feet bgs, Draft Final Remedial Investigation for Sierra Army Depot-Group III A Sites (HLA, 1994)

[c] Average of duplicate sample analyses

No detections of metal concentrations above the maximum background concentration were found at 6.5 feet and 9.5 feet bgs.

- = analyte not detected above background levels
bgs = below ground surface
CL = clay
mg/kg = milligrams per kilogram
SM = silty sand
SP = poorly graded sand
SW = well-graded sand

2.5.8.1 Surface Soil. Surface soil contamination at the Unidentified Pit was assessed on the basis of one surface soil sample collected from the surface to 0.5-foot interval at one soil boring and three discrete surface soil samples collected in the pit (Figure 2-34). The surface soil samples were analyzed for TAL metals, TCL SVOCs, and explosives. There were no detections of explosives and TCL SVOCs in investigative samples at concentrations above the CRL. Concentrations of metals detected in surface soil collected from the Unidentified Pit were compared to surface soil background concentrations. Table 2-16 and Figure 2-34 present a summary of the metals detected at concentrations greater than SIAD background concentrations for soil type 356, Honlak sandy loam.

The majority of analytes detected in surface soil from the pit that exceeded background concentrations are from soil boring UNP-1-SB. With the exception of arsenic, sodium, and thallium from this sample, the detections shown in Table 2-16 are generally comparable to SIAD background concentrations. The concentrations of arsenic, sodium, and thallium at UNP-1-SB are greater than calculated background concentrations. These analytes are not believed to be associated with disposal activities or dumping at the site. Because the groundwater level at this location is near the soil surface (1.5 feet below the bottom of the pit at the time of sample collection), the concentration of these analytes may have been influenced through a process of upward capillary action by evaporation of groundwater (Brady, 1974). As stated in Section 2.1.7, the pit is believed to have been constructed as a livestock watering pond.

The compound phenanthrene was detected in a duplicate sample of UNP-1-SB at a concentration of 0.33 mg/kg. The compound was not detected in the associated investigative sample (< 0.032 mg/kg) or in any other surface soil samples collected from the site. This isolated detection of phenanthrene is not believed to be representative of site conditions.

2.5.8.2 Subsurface Soil. Subsurface soil contamination at the Unidentified Pit was assessed on the basis of two subsurface soil samples collected from one soil boring (Figure 2-34). Soil samples collected from the boring were analyzed for TAL metals, TCL organics, and explosives. TCL organics and explosives were not detected in the subsurface soil samples at concentrations above the CRL. Table 2-17 presents a summary of the analytical results for analytes detected in subsurface soil at concentrations exceeding SIAD background concentrations for subsurface clay soils. Analytes exceeding SIAD background concentrations are from soil collected from the 1.0-foot interval of soil boring UNP-1-SB. These analytes are not believed to be associated with disposal activities at the site because the level of groundwater is near the surface at the site and, therefore the concentrations of potassium, sodium, and thallium may have been influenced through a process of upward capillary action by evaporation of groundwater (Brady, 1974).

2.5.8.3 Groundwater. Potential contamination of groundwater at the Unidentified Pit was assessed on the basis of a groundwater sample collected from accumulated water in a shallow boring within the pit (UNP-1-SB) (Figure 2-34), and from accumulated water within an adjacent boring (UNP-BKG-SB) located approximately 100 feet southwest of the pit. The sample from the adjacent boring was used to help assess background concentrations of analytes. The groundwater samples were analyzed for TAL metals, TCL organics, and explosives.

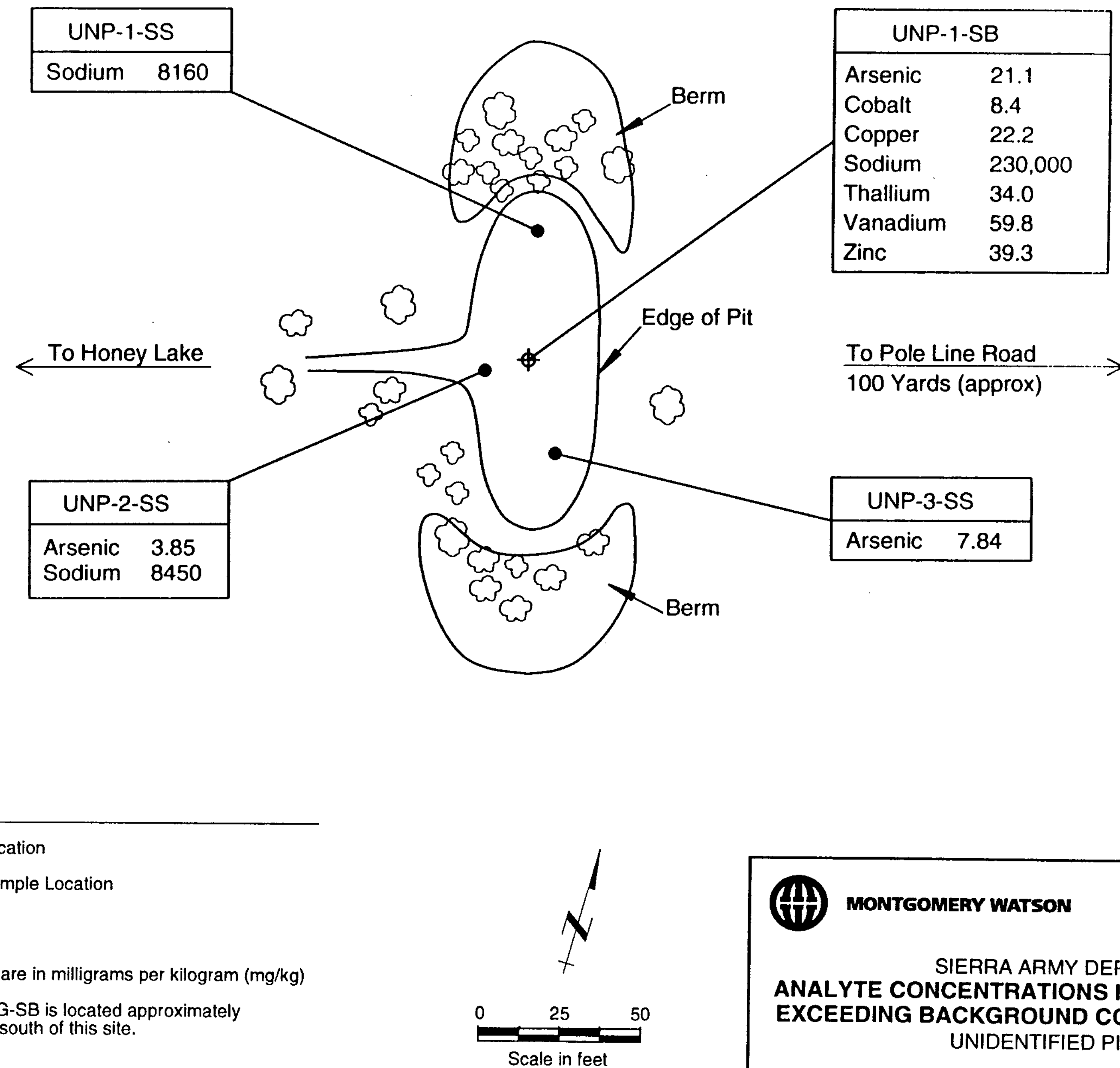
TABLE 2-16

SUMMARY OF DETECTED METAL AND SEMIVOLATILE ORGANIC COMPOUND CONCENTRATIONS
IN SURFACE SOIL THAT ARE GREATER THAN
BACKGROUND CONCENTRATIONS
UNIDENTIFIED PIT

Analytes	Sample Date:	Minimum[a] Background Concentration	Maximum[a] Background Concentration	UNP-1-SB[b] 08/21/92	UNP-1-SS[b] 08/21/92	UNP-2-SS 08/21/92	UNP-3-SS 08/21/92
Metals (mg/kg)							
Arsenic		1.60	4.61	21.1	-	-	7.84
Beryllium		0.500	0.676	-	-	-	-
Cobalt		3.73	7.49	8.39	-	-	-
Copper		7.38	20.0	22.3	-	-	-
Sodium		1,200	2,860	230,000	8,160	8,450	50,000
Thallium		6.62	13.8	34.0	-	-	-
Vanadium		16.0	54.0	59.9	-	-	68.7
Zinc		13.2	33.4	39.3	-	-	-
Semivolatile Organic Compounds (mg/kg)							
Phenanthrene				0.33[c]	-	-	-

[a] Minimum and maximum concentrations for background surface soil type 356 taken from Table 5.5, Draft Final Remedial Investigation for Sierra Army Depot-Group III A Sites (HLA, 1994)
[b] Average of duplicate sample analyses
[c] Analyte concentration in duplicate sample

- = analyte not detected at levels exceeding background
mg/kg = milligrams per kilogram



EXPLANATION

- Soil Sample Location
- Surface Soil Sample Location
- Brush

Concentrations are in milligrams per kilogram (mg/kg)

Note: UNP-BKG-SB is located approximately 200 feet south of this site.

Modified from HLA (1994).

06/94.SI

MONTGOMERY WATSON

SIERRA ARMY DEPOT

ANALYTE CONCENTRATIONS IN SURFACE SOIL EXCEEDING BACKGROUND CONCENTRATIONS

UNIDENTIFIED PIT

FIGURE 2-34

TABLE 2-17

SUMMARY OF DETECTED ANALYTE CONCENTRATIONS IN SUBSURFACE SOIL THAT ARE GREATER THAN BACKGROUND CONCENTRATIONS
UNIDENTIFIED PIT

	Minimum[a] Background Concentrations	Maximum[a] Background Concentrations	UNP-1-SB	UNP-1-SB
Depth (feet):			1.0	2.0
Sample Date:			08/21/92	08/21/92
Soil Type:	Clay and Silt[a]	Clay and Silt[a]	ML	ML
Analytes (mg/kg)				
Aluminum	28,000	28,000	32,600	-
Cobalt	12.1	15.0	17.9	-
Copper	52.8	58.6	53.8	-
Iron	27,900	27,900	37,700	-
Potassium	8,200	8,200	12,600	-
Sodium	18,500	18,500	46,800	-
Thallium	26.4	31.3	127	34.3

[a] Minimum and maximum concentrations for background subsurface silt and clay soil taken from Table 5.8, Draft Final Remedial Investigation for Sierra Army Depot-Group III A Sites (HLA, 1994)

- = analyte not detected at levels exceeding background
ML = inorganic silt

TCL organic compounds and explosives were not detected in the groundwater samples from within the Unidentified Pit or from the adjacent boring. Table 2-18 presents a summary of metal concentrations detected in the groundwater sample from within the pit that were greater than background concentrations, from the adjacent soil boring, and from background groundwater concentrations in the northwest portion of the Main Post. The reported value of 180 μg/l chromium is the only metal detection that appears to be significantly higher in the groundwater sample from UNP-1-SB than the calculated background concentration. The elevated chromium in the groundwater sample from UNP-1-SB appears anomalous because chromium was not elevated with respect to background concentrations in six soil samples from this location. Chromium was not detected above the CRL (1.04 mg/kg) in the sample collected at 2 feet below the surface from UNP-1-SB. Because the water table was encountered at about 1.5 feet below the surface in the 5.5-foot boring within the Unidentified Pit, the soil sample at 2 feet represents saturated soil. The apparent inconsistency in chromium data for soil (nondetection) versus groundwater data (180 μg/l) indicates that the elevated groundwater detections of chromium may not be representative of site conditions and may not be related to potential disposal activities at the site.

2.6 SUMMARY OF SITE RISKS

To determine the potential human health and environmental risks (both current and future) associated with exposure to contaminants at the seven sites, baseline risk assessments (BRAs) were conducted on only those sites deemed to be potential threats. These sites are: TNT Leaching Beds Area, Diesel Spill Area, Old Fire-Fighting Training Facility, and Unidentified Pit. The BRAs consisted of human health risk assessments and environmental assessments. The results of the human health risk assessments and environmental assessments are discussed in Sections 2.6.1 and 2.6.2, respectively.

BRAs were not conducted for the Nike Missile Fuel Disposal Site A, Nike Missile Fuel Disposal Site B, or the Toxic Storage Building 578 because no organic compounds were detected at these sites, and inorganic chemicals were detected at concentrations similar to background concentrations. Elevated concentrations of nitrates/nitrites were detected at the Nike Missile Fuel Disposal Site A and Nike Missile Fuel Disposal Site B; however, the concentrations detected were at levels well below the protective standards for all beneficial uses.

2.6.1 Human Health Risks

The human health risk assessment is an analysis of the potential adverse health effects (both current and future) resulting from human exposure to site contaminants. By definition, a human health risk assessment considers conditions under the no-action alternative, that is, in the absence of any remedial actions to control or mitigate exposure. The basic methodology used in the human health risk assessment was developed by the USEPA for evaluation of risk at hazardous waste sites (USEPA, 1989b). Overall, this methodology is health protective, which means that the true risks from the site are unlikely to be higher than the derived estimates, and are most likely lower. The following sections discuss the human health risk assessment methodology.

TABLE 2-18

SUMMARY OF ANALYTE CONCENTRATIONS IN GROUNDWATER THAT ARE GREATER THAN BACKGROUND CONCENTRATIONS
UNIDENTIFIED PIT

Sample Date:	Minimum[a] Background Concentrations	Maximum[a] Background Concentrations	UNP-BKG-SB[b] 12/09/92	UNP-1-SB 12/09/92
Analytes (μg/l)				
Arsenic	1,500	5,300	1,100	7,000
Barium	29.6	74.1	25	140
Beryllium	5.00	5.00	6.95	7.3
Chromium	6.02	9.62	<16.8	180
Iron	38.8	83.8	163	300
Sodium	13,000,000	14,000,000	4,300,000	25,000,000

[a] Minimum and maximum concentrations for background groundwater samples collected in soil borings located in the northwest portion of the Main Post; taken from Table 5.11, Draft Final Remedial Investigation for Sierra Army Depot-Group III A Sites (HLA, 1994)

[b] This background groundwater was collected outside of the Unidentified Pit area during the Stage 1 investigation, and therefore, was not included in the background data that was collected during Stage 2

< = less than
μg/l = micrograms per liter

2.6.1.1 Identification of Compounds of Concern. Site-specific lists of the compounds of concern (COCs) for the sites were developed through comparison to background levels, frequency of analyte detection, and contribution towards site-specific toxicity. The compounds of concern for each site are listed below:

<u>**Paint Shop Subsite Soil**</u>

For the Paint Shop Subsite, the following VOCs, SVOCs, and PAHs are COCs in soil: tetrachloroethene, toluene, xylenes, 2-chlorophenol, 1,2-dichlorobenzene, 1,3-dichlorobenzene, 1,4-dichlorobenzene, 2,4-dimethylphenol, hexachloroethane, 3-methyl-4-chlorophenol, 4-methylphenol, phenol, 1,2,4-trichlorobenzene, acenaphthene, benzo[k]fluoranthene, fluoranthene, 2-methylnaphthalene, phenanthrene, pyrene, bis(2-ethylhexyl)phthalate, and di-n-butylphthalate. All of the COCs are considered systemic toxicants (non-carcinogens). However, 1,3-dichlorobenzene does not currently have an RfD value. Tetrachloroethene, 1,4-dichlorobenzene, benzo[k]fluoranthene, and bis(2-ethylhexyl)phthalate are probable human carcinogens (Group B), and hexachloroethane is a possible human carcinogen (Group C).

<u>**TNT Leaching Beds Subsite Soil**</u>

The following explosive compounds are COCs in soil at the TNT Leaching Beds Subsite: 2,4-DNT; HMX; RDX; 1,3,5-TNB; and 2,4,6-TNT. All of these explosive compounds are systemic toxicants. 2,4-DNT is a probable human carcinogen (Group B), and RDX and 2,4,6-TNT are possible human carcinogens (Group C). As discussed previously, 1,3,5-TNB is a photolytic degradation product of 2,4,6-TNT.

<u>**TNT Leaching Beds Area Groundwater**</u>

For the TNT Leaching Beds Area, the following compounds are COCs in groundwater: arsenic, chromium, TCE, carbon tetrachloride, chloroform, 1,2-DCA, 2,4,6-TNT, 1,3,5-TNB, RDX, 2,4-DNT; 2,6,-DNT, HMX, nitrobenzene. Although arsenic has been detected at concentrations below calculated background levels as well as federal and California MCLs, arsenic was carried into the BRA based on toxicity.

<u>**Diesel Spill Area Soil and Groundwater**</u>

The COCs are diesel-related compounds.

<u>**Old Fire-Fighting Training Facility**</u>

For the Old Fire-Fighting Training Facility, potential COCs that were identified in soil are arsenic and nickel. Arsenic is a known human carcinogen via the oral and inhalation exposure routes. Nickel is a known human carcinogen via inhalation only. Although arsenic and nickel are present in on-site soil at concentrations consistent with regional background concentrations, they were originally carried through the BRA because individual concentrations exceeded site-specific background concentrations.

Unidentified Pit

For the Unidentified Pit, arsenic, thallium, and phenanthrene were identified as potential COCs in soil. Thallium may cause adverse noncarcinogenic health effects to the liver, kidneys, and the respiratory, cardiovascular, gastrointestinal, and nervous systems. Little toxicological data are available for phenanthrene, the only organic chemical detected at the site.

2.6.1.2 Exposure Assessment

TNT Leaching Beds Area

An analysis of the current human activity patterns at this site indicates that intermittent workers could be exposed to contaminated soils at both subsites. The intermittent worker is one of the base employees who works at a given site for a total of 8 hours per month performing light activity such as preparation for burning ordnance residue or unloading materials for disposal. The exposure pathways evaluated for the intermittent worker scenario are incidental soil ingestion and inhalation of fugitive dust.

Groundwater beneath the site is not currently used for potable water, thereby eliminating groundwater as a current exposure medium for this site. Contaminants in soil can be transported downward to groundwater by infiltration of rain or snow melt, and contaminated soil may serve as a continuing source of groundwater contamination. Although water supply wells are located approximately 6,500 feet south of the site, under current conditions there are no known populations using on-site groundwater for drinking or any other purpose.

Future exposure to contaminants in surface and subsurface soils at this site could occur via a construction worker laying underground utility lines or foundation footings for future military-related facilities. The exposure pathways evaluated for the future construction worker are incidental soil ingestion and inhalation of fugitive dust.

The current and planned future use of the TNT Leaching Beds Area is ammunition renovation and storage. The future residential scenario is extremely unlikely for the site. However, in order to consider health-based risk for groundwater at the TNT Leaching Beds Area, risks to a future resident were determined in the 1990 Group I RI (JMM and E.C. Jordan, 1991b). Under a future residential scenario, hypothetical on-site residents might install wells for drinking water and other indoor uses (toilets, sinks, etc.). Pathways of exposure to contaminants in groundwater used for household purposes include not only ingestion, but also dermal contact (while showering or bathing) and inhalation of volatile chemicals released from the groundwater.

Diesel Spill Area

There are no current or potential future routes of human exposure to soil contaminants at the Diesel Spill Area since there are no contaminants in surface and subsurface soil that could come in contact with potential human receptors. Exposure to groundwater by potential future residents was not quantitatively evaluated due to the low likelihood that this scenario will occur.

Old Fire-Fighting Training Facility

The Old Fire-Fighting Training Facility is located at the southern boundary of the installation in the town of Herlong. The site is currently paved, limiting human exposure to chemicals in on-site soil. The site paving restricts the exposure of nearby current off-site residents to potential COCs in dust originating in site soils. In addition, the site is not active, with no regular or intermittent visits by military workers. For these reasons, potential exposures to current off-site receptors were not evaluated for the Old Fire-Fighting Training Facility.

Potential future human receptors evaluated for the Old Fire-Fighting Training Facility include future on-site construction workers and future on-site residents. These receptors are hypothetical individuals assumed to be exposed to the COCs given the unlikely event that homes are constructed on the site at some time in the future.

Ingestion, inhalation, and dermal contact routes of exposure were evaluated for potential future receptors.

Unidentified Pit

The Unidentified Pit is located in the southwest portion of SIAD outside the installation access control fence. The site is not active, and the nearest resident is greater than 1 mile from the site. For these reasons, potential exposures of current military workers and current on-site residents were not evaluated.

Although the site is inside the Main Depot boundary, it is outside the secured area, potentially allowing access by current or future recreational users. For the purposes of the BRA, it was assumed that people could access the Unidentified Pit and use it for dirt biking or other all-terrain vehicle activities, currently and in the future.

Additional potential future human receptors evaluated for the Unidentified Pit include future on-site construction workers and future on-site residents. These receptors are hypothetical individuals assumed to be exposed to the COCs given the unlikely event that homes are constructed on the site at some time in the future.

Ingestion, inhalation, and dermal contact routes of exposure were evaluated for potential current and future receptors.

The quantification of exposure involves the calculation of an average daily intake of COCs. This intake is an approximation of exposure expressed in terms of contaminant mass at the body exchange boundary per unit body weight per day (mg/kg-day). Variability among individuals leads to a wide distribution of intake values. The variables in this equation are chosen so that estimates of two points on the distribution are calculated for each pathway: average, which is about the 50th percentile, and reasonable maximum exposure (RME) which is about the 95th percentile.

2.6.1.3 Toxicity Assessment. Cancer potency factors (CPFs) have been developed by the USEPA's Carcinogenic Assessment Group for estimating excess lifetime cancer risks associated with exposure to potentially carcinogenic chemicals. CPFs, correction factors, and the estimated intake of the carcinogen, expressed in mg/kg-day (i.e., milligram of chemical for each kilogram weight of an individual per day) are used to calculate an upper-bound estimate of the excess lifetime cancer risk associated with exposure at the estimated intake level. Use of this approach makes underestimation of the actual cancer risk highly unlikely.

The potential for noncarcinogenic adverse health effects caused by exposure to chemical contaminants is estimated through the use of reference doses (RfDs) developed by USEPA. RfDs are estimates, for a specific chemical constituent, of the lifetime human daily exposure level that is likely to be without an appreciable risk of adverse effects. The calculation of RfDs includes methods to ensure that the RfD will not underestimate the potential for adverse noncarcinogenic effects to occur. RfDs are applicable to the general population, including sensitive individuals. By comparing the RfDs with the estimated intakes of chemicals present in environmental media (e.g., the amount of a chemical ingested from drinking contaminated water), an assessment can be made of the health risks posed by the chemicals present.

Naphthalene was conservatively used as a surrogate compound to calculate noncarcinogenic risks associated with exposure to phenanthrene in soil at the Unidentified Pit.

2.6.1.4 Risk Characterization. Excess lifetime cancer risks are calculated using the assumed contaminant intake level, other exposure correction factors, and the CPF. These risks are probabilities that are generally expressed in scientific notation (e.g., $1x10^{-6}$ or 1E-06). An excess lifetime cancer risk of $1x10^{-6}$ indicates that, as a plausible upper bound, an individual has a one in one million chance of developing cancer as a result of site-related exposure to a carcinogen over a 70-year lifetime under specific exposure conditions at the site.

The USEPA OSWER Directive 9355.0-30, Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions (USEPA, 1991c) has stated that sites with an excess lifetime cancer risk less than 10^{-4} (i.e., one in 10,000) generally do not warrant remedial action. The magnitude of acceptable cancer risk relative to Superfund site remediation goals in the NCP generally ranges from 10^{-4} to 10^{-6} (one in one million) depending on the site, proposed usage, and chemicals of concern. Within this range, the level of risk that is considered to be acceptable at a specific site is a risk management decision and is decided on a case-specific basis. The acceptability of a particular level of risk is the province of risk management, where the quantitative estimates of risk are just one of many factors considered in the decision-making process. A cancer risk of 10^{-4} is not a *de facto* decision point, nor is it a "target" risk level. However, it is generally accepted that risks above this range require attention. The one-in-one-million level of risk (expressed as 10^{-6}) is often referred to as the *de minimus* level of risk. However, DTSC has not endorsed 10^{-6} as a universally acceptable level of risk.

Potential concern for noncarcinogenic effects of a single contaminant in a single medium is expressed as the Hazard Quotient (HQ) (or the ratio of the estimated intake derived from the contaminant concentration in a given medium to the contaminant's reference dose). By adding

the HQs for all contaminants within a medium or across all media to which a given population may reasonably be exposed, the Hazard Index (HI) can be generated. The HI provides a useful reference point for gauging the potential significance of multiple contaminant exposures within a single medium or across media. The HI provides a numerical indicator of the nearness to acceptable limits of exposure or the degree to which acceptable exposure levels are exceeded. If the HI is less than 1.0, then no chronic health effects are expected to occur. If the HI is greater than 1.0, then adverse health risks are possible. According to USEPA and DTSC, sites with a non-cancer hazard index (HI) less than 1.0 generally do not warrant remedial action.

TNT Leaching Beds Area

Excess lifetime cancer risk and noncancer hazard index values were calculated for the current intermittent worker, future construction worker, and future resident exposure scenarios for the TNT Leaching Beds Area (Tables 2-19 through 2-21).

The total estimated excess cancer risks for current intermittent workers at the Paint Shop Subsite range from $6x10^{-9}$ (average) to $1x10^{-7}$ (RME) (Table 2-19). Compounds contributing to these risks are arsenic and PAHs. The total estimated HI values for the same exposure scenario range from $1x10^{-5}$ (average) to $8x10^{-5}$ (RME) (Table 2-19).

The total estimated excess cancer risks for current intermittent workers at the TNT Leaching Beds Subsite range from $8x10^{-7}$ (average) to $8x10^{-6}$ (RME) (Table 2-19). 2,4-DNT, RDX, and 2,4,6-TNT contribute to these risks. The total estimated HI values for the same exposure scenario range from 0.2 (average) to 0.4 (RME) (Table 2-19). The surface soils at the TNT Leaching Beds Subsite contain high levels of explosives compounds. The explosive compounds related to nitrotoluenes (2,4-DNT, 1,3,5-TNB, and 2,4,6-TNT) and the triazine-related compounds (HMX and RDX) are hepatotoxic to rodents and might be expected to have similar toxicity towards humans. It should be noted that there are limited toxicity data available for 1,3,5-TNB; therefore, HI values calculated for this compound are considered to have a high degree of uncertainty.

The total estimated excess cancer risks for future construction workers at the Paint Shop Subsite range from $1x10^{-6}$ (average) to $6x10^{-6}$ (RME) (Table 2-20). Compounds contributing to these risks are arsenic, PAHs, and 1,4-dichlorobenzene. The total estimated HI values for the same exposure scenario range from $5x10^{-2}$ (average) to 0.1 (RME) (Table 2-20). The total estimated excess cancer risks for future construction workers at the TNT Leaching Beds Subsite range from $8x10^{-6}$ (average) to $2x10^{-5}$ (RME); these values exceed the 10^{-6} risk lead (Table 2-20). The primary compounds contributing to these risks are 2,4,6-TNT and RDX. The total estimated HI values for the same exposure scenario range from 8 (average) to 20 (RME); these values exceed the target HI value of 1.0 (Table 2-20).

The total estimated excess cancer risk for future residents exposed to groundwater at the Paint Shop Subsite is $3x10^{-3}$ (RME) (Table 2-21) which is well above the 10^{-6} risk level. Arsenic, TCE, carbon tetrachloride, chloroform, and 1,2-dichloroethane contribute to the risk. The total estimated HI value for the same exposure scenario is 20 (RME).

TABLE 2-19

SUMMARY OF CANCER AND NONCANCER RISKS
TO CURRENT INTERMITTENT WORKER
TNT LEACHING BEDS AREA

Site	Exposure Case			
	Cancer Risk		Hazard Index	
Pathway	Average	RME	Average	RME
Paint Shop Subsite				
Soil Ingestion	6E-09	1E-07	1E-05	8E-05
Soil Inhalation	NC	NC	NC	NC
Dermal	NC	NC	NC	NC
Total	6E-09	1E-07	1E-05	8E-05
TNT Leaching Beds Subsite				
Soil Ingestion	5E-07	8E-07	1E-01	2E-01
Soil Inhalation	3E-07	5E-07	7E-02	1E-01
Dermal	9E-09	7E-06	4E-03	1E-01
Total	8E-07	8E-06	2E-01	4E-01

NC = Not Calculated

TABLE 2-20

SUMMARY OF CANCER AND NONCANCER RISKS TO POTENTIAL FUTURE CONSTRUCTION WORKER TNT LEACHING BEDS AREA

Site	Exposure Case			
	Cancer Risk		Hazard Index	
Pathway	Average	RME	Average	RME
Paint Shop Subsite				
Soil Ingestion	9E-07	6E-06	5E-02	1E-01
Soil Inhalation	5E-08	8E-08	7E-04	3E-03
Dermal	NC	NC	NC	NC
Total	1E-06	6E-06	5E-02	1E-01
TNT Leaching Beds Subsite				
Soil Ingestion	7E-06	1E-05	3E+00	5E+00
Soil Inhalation	1E-07	2E-07	6E-02	1E-01
Dermal	1E-06	5E-06	5E+00	1E+01
Total	8E-06	2E-05	8E+00	15E+00

NC = Not Calculated

TABLE 2-21

SUMMARY OF CANCER AND NONCANCER RISKS
TO POTENTIAL FUTURE ADULT RESIDENT
TNT LEACHING BEDS AREA

Site	Exposure Case			
	Cancer Risk		Hazard Index	
Pathway	Average	RME	Average	RME
Paint Shop Subsite				
Groundwater Ingestion	NC	9E-04	NC	1E+01
Groundwater Inhalation	NC	2E-03	NC	1E+01
Dermal	NC	NC	NC	NC
Total	NC	3E-03	NC	2E+01
TNT Leaching Beds Subsite				
Soil Ingestion	1E-04	2E-04	2E+01	3E+01
Soil Inhalation	3E-06	6E-06	5E-01	8E-01
Dermal	1E-06	2E-04	8E-01	3E+01
Total	1E-04	4E-04	2E+01	6E+01
Groundwater Ingestion	4E-04	7E-04	2E+01	4E+01
Groundwater Inhalation	2E-05	5E-05	1E-01	4E-01
Dermal	NC	NC	NC	NC
Total	4E-04	7E-04	2E+01	4E+01

NC = Not Calculated
RME = Reasonable Maximum Exposure

The total estimated excess cancer risks for future residents exposed to groundwater at the TNT Leaching Beds Subsite range from $4x10^{-4}$ (average) to $7x10^{-4}$ (RME) (Table 2-21). The primary compounds contributing to these risks are 2,4-DNT, RDX, and 2,4,6-TNT. The total estimated HI values for this exposure scenario range from 20 (average) to 40 (RME).

<u>**Old Fire-Fighting Training Facility**</u>

Current receptors were not identified for the Old Fire-Fighting Training Facility.

The total estimated cancer risks for future construction workers at this site range from $1x10^{-6}$ (average) to $4x10^{-6}$ (RME) (Table 2-22), primarily due to arsenic inhalation. These values are within the $1x10^{-6}$ to $1x10^{-4}$ risk management range. The total estimated HI values for the same exposure scenario range from $6x10^{-2}$ (average) to $2x10^{-1}$ (RME) (Table 2-22).

The total estimated cancer risks for future residents at the Old Fire-Fighting Training Facility range from $2x10^{-5}$ (average) to $1x10^{-4}$ (RME) (Table 2-23), primarily due to arsenic ingestion. The total estimated HI values for future residents at this site range from $4x10^{-1}$ (average) to 2 (RME) (Table 2-23). The RME estimated HI value of 2 was primarily due to ingestion of arsenic in soil, which may represent an overestimation of potential noncarcinogenic effects because it was estimated for the more conservative and, therefore less likely, RME exposure scenario.

<u>**Unidentified Pit**</u>

The total estimated excess cancer risks for current recreational users at the Unidentified Pit range from $2x10^{-5}$ (average) to $7x10^{-4}$ (RME) (Table 2-24), due to arsenic inhalation. The total estimated HI values for the same exposure scenario range from $9x10^{-2}$ (average) to 1 (RME) (Table 2-24), primarily due to thallium ingestion. The total estimated excess cancer risks and HI values for future recreational users at the Unidentified Pit (Table 2-24) are the same as those discussed above for current recreational users.

The total estimated cancer risks for future construction workers at the Unidentified Pit range from $4x10^{-7}$ (average) to $1x10^{-6}$ (RME) (Table 2-25), due to arsenic inhalation. The total estimated HI values for the same scenario range from $2x10^{-1}$ (average) to $7x10^{-1}$ (RME) (Table 2-25).

The total estimated cancer risks for future residents at the Unidentified Pit range from $1x10^{-5}$ (average) to $9x10^{-5}$ (RME) (Table 2-26), due to arsenic ingestion. The total estimated HI values for future residents at the Unidentified Pit range from 9 (average) to 30 (RME) (Table 2-26), primarily due to ingestion of thallium in soil. These HI values of greater than 1.0 indicate that possible adverse noncarcinogenic health effects may be of concern at the Unidentified Pit in the unlikely event residences are established on site.

2.6.1.5 Summary. The current exposure scenario for the TNT Leaching Beds Area is the intermittent worker. Potential cancer and noncancer risks to current intermittent workers

TABLE 2-22

SUMMARY OF CANCER AND NONCANCER RISKS TO POTENTIAL FUTURE CONSTRUCTION WORKER OLD FIRE-FIGHTING TRAINING FACILITY

Site	Exposure Case			
	Cancer Risk		Hazard Index	
Pathway	Average	RME	Average	RME
Old Fire-Fighting Training Facility				
Soil Ingestion	4E-07	2E-06	5E-02	2E-01
Soil Inhalation	8E-07	2E-06	NA	NA
Dermal	2E-08	3E-07	3E-03	3E-02
Total	1E-06	4E-06	6E-02	2E-01

RME = Reasonable maximum exposure
NA = Not available

TABLE 2-23

SUMMARY OF CANCER AND NONCANCER RISKS
TO POTENTIAL FUTURE RESIDENT
OLD FIRE-FIGHTING TRAINING FACILITY

	Exposure Case			
Site	Cancer Risk		Hazard Index	
Pathway	Average	RME	Average	RME
Old Fire-Fighting Training Facility				
Soil Ingestion	2E-05	8E-05	3E-01	1E+00
Soil Inhalation	1E-06	6E-06	NA	NA
Dermal	2E-06	4E-05	3E-02	3E-01
Total	2E-05	1E-04	4E-01	2E+00

RME = Reasonable maximum exposure
NA = Not available

TABLE 2-24

SUMMARY OF CANCER AND NONCANCER RISKS
TO CURRENT/FUTURE RECREATIONAL USER
UNIDENTIFIED PIT

Site	Exposure Case			
	Cancer Risk		Hazard Index	
Pathway	Average	RME	Average	RME
Unidentified Pit				
Soil Ingestion	4E-07	9E-06	8E-02	1E+00
Soil Inhalation	2E-05	7E-04	3E-06	5E-05
Dermal	4E-08	4E-06	8E-03	2E-01
Total	2E-05	7E-04	9E-02	1E+00

RME = Reasonable maximum exposure

TABLE 2-25

SUMMARY OF CANCER AND NONCANCER RISKS TO POTENTIAL FUTURE CONSTRUCTION WORKER UNIDENTIFIED PIT

Site	Exposure Case			
	Cancer Risk		Hazard Index	
Pathway	Average	RME	Average	RME
Unidentified Pit				
Soil Ingestion	3E-07	1E-06	2E-01	6E-01
Soil Inhalation	7E-08	2E-07	7E-08	2E-07
Dermal	1E-08	2E-07	8E-03	9E-02
Total	4E-07	1E-06	2E-01	7E-01

RME = Reasonable maximum exposure

TABLE 2-26

SUMMARY OF CANCER AND NONCANCER RISKS
TO POTENTIAL FUTURE RESIDENT
UNIDENTIFIED PIT

Site	Exposure Case			
	Cancer Risk		Hazard Index	
Pathway	Average	RME	Average	RME
Unidentified Pit				
Soil Ingestion	1E-05	6E-05	8E+00	3E+01
Soil Inhalation	9E-07	4E-06	1E-07	4E-07
Dermal	1E-09	2E-05	7E-01	6E+00
Total	1E-05	9E-05	9E+00	3E+01

RME = Reasonable maximum exposure

exposed to soils at both subsites are considered acceptable according to current USEPA and DTSC guidelines. Future exposure to contaminants in surface and subsurface soils at the TNT Leaching Beds Area was evaluated via a scenario in which a construction worker installs underground utility lines or foundation footings for future military-related facilities. Potential cancer risks to future construction workers exposed to leaching bed soils are acceptable but potential noncancer risks for the same scenario are unacceptable. Estimated cancer and noncancer risks to future construction workers are considered acceptable for the Paint Shop Subsite soil.

There are no current or potential future routes of exposure to soil contaminants at the Diesel Spill Area since there are no contaminants in surface and subsurface soil that could come in contact with potential human receptors.

The risk assessment results for the Old Fire-Fighting Training Facility reveal that long-term, continuous exposure to arsenic in soil may pose a slight health risk to a future construction worker or resident. However, potential future uses at this site do not include use as a residential area.

For the Unidentified Pit, potential human health risks were identified for current and future receptors due to ingestion of arsenic and thallium in soil, and inhalation of arsenic in dust. These metals are present as a result of the concentration of metals in the bottom of the Unidentified Pit due to evaporation. The Army has agreed to replace the excavated soil back into the pit, thereby removing the potential for adverse exposure at this site.

2.6.1.6 Uncertainties. There are a number of stages in the risk assessment process where precise evaluations are not possible. These include uncertainties regarding the true concentrations of chemicals in environmental media, the amount of contaminants taken in by humans, and the likely consequences of the resulting exposure. Some of these limitations lead to an underestimate of risk (e.g., lack of appropriate toxicity data, inability to quantify some exposure pathways), while other assumptions and professional judgments made are more likely to overestimate than underestimate risk. Consequently, the risks derived for the four sites should be considered to be only approximate.

2.6.2 Environmental Risks

Environmental assessments were conducted to assess the potential risks to plants and animals due to the presence of potential COCs in soils at the seven sites. Potential environmental receptors include birds, mammals, reptiles, and plants. The peregrine falcon, bald eagle, and Swainson's hawk are considered to be the most sensitive species identified at SIAD. The peregrine falcon and bald eagle are on the federal Endangered Species List, and the Swainson's hawk is listed on the California Threatened and Endangered Species List. No evidence of adverse impacts of site-specific chemicals on plants and animals in the vicinity of the seven sites was identified during preparation of the environmental assessments. Impacts to water quality were not evaluated in the environmental assessments as these assessments focused on potential impacts

to ecological receptors. Potential impacts to water quality are discussed in Sections 2.8.1.1, 2.8.1.2, 2.8.1.3, and 2.8.1.4 of this ROD/RAP.

However, actual or threatened releases of hazardous substances from these sites, if not addressed by implementing the response actions selected in the ROD/RAP, may present an imminent and substantial endangerment to public health, welfare, or the environment.

2.7 DESCRIPTION OF ALTERNATIVES

This section discusses the remedial alternatives that have been developed for the TNT Leaching Beds Subsite soil, Paint Shop Subsite soil, TNT Leaching Beds groundwater, and Diesel Spill Area soil and groundwater. As discussed previously, no further action is recommended for the remaining five sites.

2.7.1 Paint Shop Subsite Soil

Three alternatives were developed for detailed analysis in the feasibility study report for the Paint Shop Subsite soil (Montgomery Watson, 1993a). The remedial alternatives are:

- Alternative 1 - No Action
- Alternative 2 - Institutional Controls
- Alternative 3 - Excavation and Off-Site Treatment/Disposal

2.7.1.1 Alternative 1 - No Action. The no-action alternative serves as a baseline for comparison with other remedial alternatives. No remedial actions would be performed at the Paint Shop Subsite to eliminate future potential exposure pathways, and thus any risks to human health and the environment would not be reduced. Since contaminants would remain on site, the site would be reviewed every 5 years, as required under CERCLA. The total present-worth cost for this alternative is $11,000.

2.7.1.2 Alternative 2 - Institutional Controls. This alternative would consist of using institutional controls to minimize exposure to soil contaminants at the Paint Shop Subsite. The subsite would be fenced to restrict humans from coming in close contact with the contaminated soil. Since contaminants would remain on site, the site would be reviewed every 5 years, as required under CERCLA. The total present-worth cost for this alternative is $81,000.

2.7.1.3 Alternative 3 - Excavation and Off-Site Treatment/Disposal. This alternative consists of excavating approximately 110 cubic yards (140 tons) of soil and transporting it to an off-site facility for treatment and disposal. It is assumed that the soil would be treated using incineration. Following treatment, the soil could be disposed in an appropriately licensed landfill. The excavated soil would be replaced with clean fill. The total present-worth cost for this alternative is $480,000.

2.7.2 TNT Leaching Beds Subsite Soil

Four alternatives were developed for detailed analysis in the feasibility study report for the TNT Leaching Beds Subsite soil (Montgomery Watson, 1993a). The remedial alternatives are:

- Alternative 1 - No Action
- Alternative 2 - Capping
- Alternative 3 - Excavation and On-Site Composting
- Alternative 4 - Excavation and Off-Site Treatment/Disposal

2.7.2.1 Alternative 1 - No Action. This alternative is the same as the no-action alternative for the Paint Shop Subsite soil. The total present-worth cost for this alternative is $11,000.

2.7.2.2 Alternative 2 - Capping. This alternative consists of capping the contaminated leaching beds soil to reduce exposure to current receptors, and implementing institutional controls to prevent exposure to potential future receptors. The site would be capped using a multi-layer RCRA cap. Following cap construction, the site would be fenced. Since contaminants would remain on site, the site would be reviewed every 5 years as required by CERCLA. The total present-worth cost for this alternative is $390,000.

2.7.2.3 Alternative 3 - Excavation and On-Site Composting. This alternative consists of excavating approximately 1,750 cubic yards (cy) (2,300 tons) of soil and treating it on site using composting. The soil would be excavated using conventional excavation equipment. Composting is a controlled biological process by which biodegradable materials are converted by microorganisms to nontoxic byproducts. In most cases, this is achieved by the use of indigenous microorganisms.

Contaminated soils would be mixed with bulking agents such as wood chips, and organic amendments such as animal, fruit, and vegetable wastes. It is assumed that windrow composting would be used. Composting would result in approximately a twofold volumetric increase in material due to the addition of amendment material. A temporary structure would be used to prevent potential wind dispersal of explosives-contaminated dusts, and a lined pad would be constructed to prevent possible leaching of explosives into the ground.

Based on the results of bench- and pilot-scale composting studies performed at other Army facilities, it is anticipated that the time required to complete the composting remedial action is approximately 1 year. Soil samples would be collected and analyzed on a periodic basis to monitor the effectiveness of treatment. Once treatment is complete, it is assumed that approximately half of the compost material would be backfilled. Any excess compost material that cannot be backfilled will be disposed off site at an appropriately licensed landfill. A treatability study would be required prior to full-scale implementation of composting at the TNT Leaching Beds Subsite. The total present-worth cost for this alternative is $1.4 million.

2.7.2.4 Alternative 4 - Excavation and Off-Site Treatment/Disposal. This alternative consists of excavating approximately 1,750 cy (2,300 tons) of soil and transporting it off site to a commercial facility for incineration treatment and disposal. Clean fill would be imported to the site for backfilling the excavation. The fill would be compacted and graded to promote surface runoff away from the former excavation. The total present-worth cost for this alternative is $7.7 million.

2.7.3 TNT Leaching Beds Area Groundwater

Five alternatives were developed for detailed analysis in the feasibility study report for the TNT Leaching Beds Area groundwater (Montgomery Watson, 1993b). Since the TCE plume at the Paint Shop Subsite and the explosives plume at the TNT Leaching Beds Subsite overlap, remedial alternatives were developed for the combined plumes. The remedial alternatives are:

Alternative 1 - No Action

Alternative 2 - Natural Attenuation and Degradation

Alternative 3 - Extraction and Treatment with Granular Activated Carbon (GAC) Adsorption

Alternative 4 - Extraction and Treatment with Air Stripping and GAC Adsorption

Alternative 5 - Extraction and Treatment with Air Stripping and UV Oxidation

2.7.3.1 Alternative 1 - No Action. As with the no-action alternatives for soils, the no-action alternative for groundwater serves as a baseline for comparison with other remedial alternatives. No remedial actions would be performed at the TNT Leaching Beds Area to eliminate future potential exposure pathways, and thus any risks to human health and the environment would not be reduced. Groundwater monitoring will continue by using the existing well network at the site until year 30. The results of continued groundwater monitoring would be used to monitor possible migration of contaminants and the impacts of any infiltration that may reach the groundwater. However, the objective of the no-action alternative would not be an evaluation of natural attenuation and degradation. No performance standards would be monitored. Because contaminants would remain on site, the site would be reviewed every 5 years as required by CERCLA. The total present-worth cost for this alternative is $1.1 million.

2.7.3.2 Alternative 2 - Natural Attenuation and Degradation. This alternative evaluates the restoration of groundwater by an evaluation of attenuation and degradation processes that naturally occur within the aquifer. The alternative consists of:

- Further characterization of site hydrogeology
- Evaluation of natural attenuation/degradation and contaminant migration rates

- Institutional controls to minimize exposure to groundwater contaminants at the site
- Groundwater monitoring to measure contaminant degradation and migration rates

The proposed program of further hydrogeologic characterization will include drilling, logging, and sampling of six deep soil borings to provide more detailed data on the hydrogeology of the site. Additional groundwater monitoring wells will be installed and additional groundwater samples will be collected by drive sampling at various depths and locations throughout the TNT Leaching Beds Area. The number of borings, monitoring wells, and groundwater samples will depend upon the types of sediments and extent of groundwater contamination encountered. Flowcharts showing the decision trees for installing the additional wells are presented in the Army's October 22, 1993 letter to the State of California. The proposed program may include up to 15 deep soil borings, 36 monitoring wells, and 15 groundwater samples collected by drive samplers. The exact number of soil borings, groundwater monitoring wells, and groundwater samples will be determined in the Remedial Design/Remedial Action (RD/RA) Phase and will not require a modification of this ROD/RAP if different from this proposal. Furthermore, additional soil borings and/or groundwater monitoring wells may be deemed necessary during the 5-year study and will be negotiated through the FFSRA. During the first year of groundwater monitoring, monitoring data will be collected on a quarterly basis and elevation data will be collected on a monthly basis. From the first to fifth year, groundwater monitoring data will be collected on an annual basis, if deemed appropriate. An initial list of monitoring parameters and the rationale for monitoring those parameters is provided in Table 2-27. Groundwater modeling may also be conducted, if warranted. Specific details of the groundwater monitoring and evaluation program will be established in the RD/RA Phase and may be modified through the FFSRA without revision of this ROD/RAP. The Army will submit status reports on the results of groundwater monitoring to the State of California based on the following schedule:

- No later than 18 months after the effective (last signature) date of the ROD/RAP
- No later than 36 months after the effective date of the ROD/RAP
- No later than 5 years after the effective date of the ROD/RAP

During or following completion of the 5-year groundwater monitoring program, the Army and State of California will review all hydrogeologic and chemical data to determine whether further implementation of the natural attenuation and degradation alternative is appropriate. If the extent of horizontal and vertical contaminant migration and apparent rates of contaminant migration and degradation are not acceptable to either the Army or State of California, Alternative 2 will not be further implemented and a contingency alternative will be implemented. The contingency alternative consists of Alternative 4 (Groundwater Extraction and Treatment with Air Stripping and GAC Adsorption) discussed in Section 2.7.3.4. In the event that the contingency alternative is implemented, the Army will work with the State of California who will develop Substantive Waste Discharge Requirements for the disposal of treated groundwater. Those Substantive Waste Discharge Requirements will specify the appropriate effluent discharge standards, monitoring programs, and other relevant performance criteria.

TABLE 2-27

TNT LEACHING BEDS AREA GROUNDWATER MONITORING PARAMETERS

Parameter	Rationale for Monitoring
Volatile Organic Compounds	Measure contaminant concentrations in aquifer.
Explosive Compounds	Measure contaminant concentrations in aquifer.
Total Petroleum Hydrocarbons Diesel	Measure contaminant concentrations in aquifer.
Dissolved Oxygen (DO)	To determine if aerobic or anaerobic conditions prevail in groundwater.
Oxidation Potential (Eh)	To determine if aerobic or anaerobic conditions prevail in groundwater.
Alternate Electron Acceptors (e.g., nitrate, sulfate/sulfide, iron III, carbonate, ammonia, phosphate, manganese)	The presence of alternate electron acceptors is necessary for anaerobic biodegradation.
Methane	Characteristic of anaerobic biodegradation through methanogenesis.
Conductivity (EC)	Field measurement that will help determine stability of groundwater prior to sampling.
pH	Field measurement that will help determine stability of groundwater prior to sampling as well as help determine if the groundwater is conducive to microbial activity.
Additional explosives analysis (possibly a Reverse Phase - HPLC method)	Used intermittently on selected wells to determine the presence of 1,3,5-trinitrobenzene degradation products not targeted with method 8330.

However, the Army may propose a new contingency alternative that is superior to Alternative 4 prior to the end of the 5-year study period. Upon agreement by the Army and State of California, the new contingency alternative will be evaluated and implemented. The schedule for selection and implementation of the new contingency alternative will follow the procedures specified in Section 8 (Deadlines) of the SIAD Federal Facility Site Remediation Agreement (FFSRA). The Army will continue to periodically review the feasibility of natural attenuation and degradation and other potential remedial technologies. If any action taken during the 5-year period leads to a dispute, such dispute will be resolved via Section 12 (Dispute Resolution) of the SIAD FFSRA.

If, during or following completion of the 5-year groundwater monitoring program, the extent of horizontal and vertical contaminant migration and apparent rates of contaminant migration and degradation are acceptable to the Army and State of California, long-term groundwater monitoring and institutional controls will be implemented. The frequency of subsequent groundwater monitoring will be determined following a review of site data conducted 5 years after the implementation of Alternative 2. Future site review activities will be conducted every 5 years pursuant to CERCLA §121(c) to assure that contaminant migration and degradation rates are within ranges that are acceptable to the Army and State of California. Institutional controls would restrict the use of groundwater at the site during the long-term groundwater monitoring. The total present-worth cost for this alternative is $1.9 million.

2.7.3.3 Alternative 3 - Extraction and Treatment with GAC Adsorption. This alternative consists of extracting groundwater and treating it aboveground using GAC adsorption. With GAC adsorption, organic contaminants are removed from a water stream by passing the stream through a bed of activated carbon that adsorbs the organic compounds. Twelve extraction wells would be used to extract groundwater. The liquid-phase GAC adsorption treatment system would consist of two pressurized vessels in series, each containing 10,000 pounds of GAC. A series of 12 reinjection wells would be installed to return treated water to the ground and enhance plume control. Institutional controls would be implemented at the site and the site would be reviewed every 5 years because contaminants would remain in groundwater for the duration of this alternative. To evaluate the effectiveness of the alternative, groundwater would be monitored using the existing well network on a semiannual basis for the first 5 years and then annually thereafter. The total present-worth cost for this alternative is $9.5 million.

2.7.3.4 Alternative 4 - Extraction and Treatment with Air Stripping and GAC Adsorption. This alternative is the same as Alternative 3 except that the groundwater would be treated using air stripping and GAC adsorption. Air stripping is a process in which VOCs in water are transferred to air by passing the water stream through a packed tower in which air is passing countercurrently. For costing purposes, it is assumed that the air stripping tower would be approximately 30 feet in height and 2.5 feet in diameter.

The Lassen County Air Pollution Control District has indicated that the need for emissions controls is assessed on a site-specific basis. Although it is anticipated that treatment of air emissions will not be required, it is assumed that effluent gases containing VOCs from the air

stripper would be treated using vapor phase GAC adsorption to reduce the toxicity and mobility of the VOCs. The total present-worth cost for this alternative is $5.7 million.

2.7.3.5 Alternative 5 - Extraction and Treatment with Air Stripping and UV Oxidation. This alternative is the same as Alternative 3 except that the groundwater would be treated using air stripping and UV oxidation. UV oxidation destroys organic compounds in groundwater by utilizing UV radiation and chemical oxidants such as hydrogen peroxide. The total present-worth cost for this alternative is $9.6 million.

2.7.4 Diesel Spill Area Soil and Groundwater

Five alternatives were developed for detailed analysis in the feasibility study reports for the Diesel Spill Area (Montgomery Watson, 1993a,b; 1994). The remedial alternatives are:

- Alternative 1 - No Action
- Alternative 2 - Bioventing and Natural Attenuation and Degradation
- Alternative 3 - Bioventing and Extraction and Treatment with GAC Adsorption
- Alternative 4 - Bioventing and Extraction and Treatment with UV Oxidation
- Alternative 5 - Bioventing and Air Sparging
- Alternative 6 - Bioventing and Vacuum Vapor Extraction

2.7.4.1 Alternative 1 - No Action. This alternative is the same as the no-action alternatives for the TNT Leaching Beds Area. The total cost for this alternative is $251,000.

2.7.4.2 Alternative 2 - Bioventing and Natural Attenuation and Degradation. This alternative would utilize in situ bioventing to treat diesel-related compounds in subsurface soil at the Diesel Spill Area. Bioventing is an innovative technology that combines the physical processes of soil venting with the degradation potential of enhanced biodegradation. Bioventing would draw air through the soil to stimulate microorganisms to biodegrade the fuel hydrocarbons. Aeration of the soil would be achieved using two air injection vents installed at the site. Institutional controls would be used to control potential future exposure to groundwater contaminants by preventing the installation of water supply wells on site. Groundwater monitoring and 5-year site review activities would also be conducted at the site as discussed for the no-action alternative. The total cost for this alternative is $900,000.

2.7.4.3 Alternative 3 - Bioventing and Extraction and Treatment with GAC Adsorption. As with Alternative 2, this alternative uses bioventing to degrade diesel contaminants in soil. Groundwater would be extracted using one well and treated aboveground using GAC adsorption. The GAC adsorption treatment system would consist of two pressurized vessels in series, each containing 900 pounds of GAC. One reinjection well would be installed to return treated water to the ground. Since groundwater remediation is estimated to take over 50 years, institutional controls (deed restrictions) would be implemented and the site would be reviewed every 5 years. The estimated total cost for this alternative is $2.6 million.

2.7.4.4 Alternative 4 - Bioventing and Extraction and Treatment with UV Oxidation. This alternative is the same as Alternative 3 except that the groundwater would be treated using UV oxidation. The estimated total cost for this alternative is $4.3 million.

2.7.4.5 Alternative 5 - Bioventing and Air Sparging. This alternative uses bioventing to remediate soil and air sparging to remediate groundwater. Air sparging involves injecting air into groundwater to enhance the natural biodegradation of the diesel. Aeration of soil and groundwater would be achieved using a series of 11 nested air extraction vents (soil) and air injection wells (groundwater). Air would be extracted from the vents to draw air through the soil and to recover air injected into the groundwater. Since approximately one-third of the diesel plume is located underneath a large earthen berm at the site (Figure 2-28), two air sparging wells would be installed at an angle in the berm to achieve aeration of this portion of the plume. Air extracted from the vadose zone vents would be treated with GAC to remove any volatiles present in the air stream. This alternative is estimated to take approximately 4 years to restore soil and groundwater at the site. A treatability study would be performed prior to implementation. The estimated total cost for this alternative is $972,000.

2.7.4.6 Alternative 6 - Bioventing and Vacuum Vapor Extraction. This alternative utilizes bioventing to remediate soil and vacuum vapor extraction to remediate groundwater. Bioventing of the soil would be achieved using two air injection vents within the area of soil contamination. Unlike Alternative 5, this alternative requires only two bioventing vents because the vacuum vapor extraction well would not inject large volumes of air into the aquifer such that air extraction vents installed in the vadose zone above the diesel plume would be required. The vacuum vapor extraction technology uses specially designed wells with upper and lower screen zones to create a vertical circulation pattern in the aquifer. As water is circulated in the aquifer, oxygen enrichment occurs in situ thereby enhancing natural biodegradation. It is assumed that one vacuum vapor extraction well will be sufficient to treat the groundwater. This alternative is estimated to take approximately 4 years to restore soil and approximately 6 years to restore groundwater. The estimated cost for this alternative is $1.0 million.

2.8 SUMMARY OF COMPARATIVE ANALYSIS OF ALTERNATIVES

The remedial alternatives developed in the feasibility studies for the TNT Leaching Beds Area and Diesel Spill Area were analyzed in detail using the nine evaluation criteria required by the NCP (40 CFR 300.430(e)(9)). These criteria are classified as threshold criteria, primary balancing criteria, and modifying criteria. Threshold criteria are:

(1) Overall protection of human health and the environment
(2) Compliance with ARARs

Primary balancing criteria are:

(3) Long-term effectiveness and permanence
(4) Reduction of toxicity, mobility, or volume through treatment
(5) Short-term effectiveness

(6) Implementability
(7) Cost

Modifying criteria are:

(8) State/support agency acceptance
(9) Community acceptance

The resulting strengths and weaknesses of the alternatives were then weighed to identify the alternative providing the best balance among the nine criteria. Figures 2-35 through 2-38 summarize this comparison for the Paint Shop Subsite soil, TNT Leaching Beds Subsite soil, TNT Leaching Beds Area groundwater, and Diesel Spill Area soil and groundwater.

2.8.1 Overall Protection of Human Health and the Environment

This criterion is an overall assessment of whether a remedy provides adequate protection of human health and the environment. The evaluation focuses on a determination of the degree to which a specific alternative achieves adequate protection and describes the manner in which site risks are eliminated, reduced, or controlled through treatment, engineering, or institutional measures. The potential for cross-media impacts is also assessed.

2.8.1.1 Paint Shop Subsite Soil. The baseline risk assessment determined that potential cancer and noncancer risks for current and future exposure scenarios are acceptable according to current USEPA and DTSC guidelines ($<10^{-4}$ risk level). Potential cancer risks to future construction workers are considered acceptable according to current USEPA guidelines but are slightly above the 10^{-6} risk level. The baseline risk assessment also concluded that contaminated soils at this subsite pose minimal risks to ecological receptors due to the small areal extent of soil contamination.

Although human health and ecological risks are within acceptable ranges, the Army has determined that remediation of the contaminated soil is beneficial to the overall protection of human health and the environment. Therefore, it is assumed for the excavation/treatment/disposal alternative presented in the FS (Alternative 3) that soils would be excavated to a depth below which untreated soils would not pose a cancer risk greater than 10^{-6} and a noncancer health index greater than 1.0 under a future construction worker scenario. To evaluate to what depth soils should be excavated for treatment and disposal, health-based remediation levels were calculated (Table 2-28). All health-based remediation levels were calculated assuming a future, 6-month, construction worker scenario based on the ingestion and inhalation pathways.

The future construction worker scenario represents 5 days a week, 8 hours/day, 250 days/year for 6 months, with an inhalation rate of 20 m^3 along with an ingestion rate of 480 mg/day. The cleanup levels for subsurface soils at the Paint Shop Subsite have been calculated based on California EPA guidance: Supplemental Guidance for Human Health Multimedia Risk Assessments of Hazardous Waste Sites and Permitted Facilities, Department of Toxic Substance Control (October 1992).

ALTERNATIVE	PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	COMPLIANCE WITH ARARs	EFFECTIVENESS	REDUCTION OF TOXICITY, MOBILITY, AND VOLUME (TMV)	IMPLEMEN-TABILITY	TOTAL COST [a] ($)	STATE ACCEPTANCE	COMMUNITY ACCEPTANCE
1 (NO ACTION)	Potential for Future Exposure Remains	Does Not Comply [b]	Not Effective	No Reduction in TMV	No Technical Limitations	11,000	Unacceptable	Unacceptable
2 (INSTITUTIONAL CONTROLS)	Potential for Future Exposure Is Reduced	Does Comply	Effective	No Reduction in TMV	Easily Implemented	81,000	Unacceptable	Unacceptable
3 (EXCAVATION AND OFF-SITE TREATMENT/ DISPOSAL)	**Potential for Future Exposure Is Significantly Reduced**	**Does Comply**	**Effective**	**Signficant Reduction in TMV**	**Easily Implemented**	**480,000**	**Acceptable**	**Acceptable**

Preferred alternative is shaded.

a Based on 30-year present-worth cost.

b Although SWRCB Resolution No. 92-49 and CCR Title 23, Division 3, Chapter 15 are action-specific ARARs, no chemical-specific ARARs were identified.

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SUMMARY OF ALTERNATIVES-PAINT SHOP SUBSITE SOIL

FIGURE 2-35

ALTERNATIVE	PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	COMPLIANCE WITH ARARs	EFFECTIVENESS	REDUCTION OF TOXICITY, MOBILITY, AND VOLUME (TMV)	IMPLEMEN-TABILITY	TOTAL COST [a] ($)	STATE ACCEPTANCE	COMMUNITY ACCEPTANCE
1 (NO ACTION)	Potential for Future Exposure Remains	Does Not Comply [b]	Not Effective	No Reduction in TMV	No Technical Limitations	11,000	Unacceptable	Unacceptable
2 (CAPPING)	Potential for Future Exposure is Reduced	Does Comply [b]	Effective	No Reduction in TMV	Easily Implemented	390,000	Acceptable	Unacceptable
3 (EXCAVATION AND ON-SITE COMPOSTING)	**Potential for Future Exposure is Significantly Reduced**	**Does Comply**	**Effective**	**Significant Reduction in TMV**	**Easily Implemented**	**1.4 Million**	**Acceptable**	**Acceptable**
4 (EXCAVATION AND OFF-SITE TREATMENT/ DISPOSAL)	Potential for Future Exposure is Significantly Reduced	Does Comply	Effective	Significant Reduction in TMV	Easily Implemented	7.7 Million	Acceptable	Acceptable

Preferred alternative is shaded.

a Based on 30-year present-worth cost.

b Although SWRCB Resolution No. 92-49 and CCR Title 23, Division 3, Chapter 15 are action-specific ARARs, no chemical-specific ARARs were identified.

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SUMMARY OF ALTERNATIVES-
TNT LEACHING BEDS SUBSITE SOIL

FIGURE 2-36

ALTERNATIVE	PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	COMPLIANCE WITH ARARs	EFFECTIVENESS	REDUCTION OF TOXICITY, MOBILITY, AND VOLUME (TMV)	IMPLEMENTABILITY	TOTAL COST [a] ($)	STATE ACCEPTANCE	COMMUNITY ACCEPTANCE
1 (NO ACTION)	Potential for Future Exposure Remains	Does Not Comply	Not Effective	Reduction in TMV [c]	No Technical Limitations	1.1 Million	Unacceptable	Unacceptable
2 (NATURAL ATTENUATION AND DEGRADATION)	Potential for Future Exposure is Significantly Reduced	Please See Footnote [b]	Effective	Reduction in TMV [c]	Easily Implemented	1.9 Million	Acceptable	Acceptable
3 (EXTRACTION AND TREATMENT WITH GAC ADSORPTION)	Potential for Future Exposure is Significantly Reduced	Compliance is Achievable	Effective	Reduction in TMV	Easily Implemented	9.5 Million	Acceptable	Acceptable
4 (EXTRACTION AND TREATMENT WITH AIR STRIPPING AND GAC ADSORPTION)	Potential for Future Exposure is Significantly Reduced	Compliance is Achievable	Effective	Reduction in TMV	Easily Implemented	5.7 Million	Acceptable	Acceptable
5 (EXTRACTION AND TREATMENT WITH AIR STRIPPING AND UV OXIDATION)	Potential for Future Exposure is Significantly Reduced	Compliance is Achievable	Effective	Reduction in TMV	Easily Implemented	9.6 Million	Acceptable	Acceptable

Preferred alternative is shaded.

a Based on 30-year present-worth cost.

b A groundwater monitoring network would be established to assure that there is no significant contaminant migration and that the rate of contaminant degradation is acceptable. Allowable concentrations of compounds of concern will be determined by the State of Califorinia during long-term groundwater monitoring.

c Reduction in TMV will depend on natural attenuation and degradation of contaminants.

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SUMMARY OF ALTERNATIVES-TNT LEACHING BEDS AREA GROUNDWATER

FIGURE 2-37

ALTERNATIVE	PROTECTION OF HUMAN HEALTH AND THE ENVIRONMENT	COMPLIANCE WITH ARARs	EFFECTIVENESS	REDUCTION OF TOXICITY, MOBILITY, AND VOLUME (TMV)	IMPLEMEN-TABILITY	TOTAL COST [a] ($)	STATE ACCEPTANCE	COMMUNITY ACCEPTANCE
1 (NO ACTION)	Potential for Future Exposure Remains	Does Not Comply	Not Effective	No Reduction in TMV	No Technical Limitations	251,000	Unacceptable	Unacceptable
2 (BIOVENTING AND NATURAL ATTENUATION AND DEGRADATION)	Potential for Future Exposure is Reduced	Please See Footnote [b]	Effective	Reduction in TMV[c]	Easily Implemented	900,000	Unacceptable	Unacceptable
3 (BIOVENTING AND PUMP-AND-TREAT WITH GAC)	Potential for Future Exposure is Significantly Reduced	Compliance is Achievable	Effective	Reduction in TMV	Easily Implemented	2.6 Million	Acceptable	Acceptable
4 (BIOVENTING AND PUMP-AND-TREAT WITH UV OXIDATION)	Potential for Future Exposure is Significantly Reduced	Compliance is Achievable	Effective	Reduction in TMV	Easily Implemented	4.3 Million	Acceptable	Acceptable
5 (BIOVENTING AND AIR SPARGING)	Potential for Future Exposure is Significantly Reduced	Compliance is Achievable	Effective	Reduction in TMV	Easily Implemented	972,000	Acceptable	Acceptable
6 (BIOVENTING AND VACUUM VAPOR EXTRACTION)	Potential for Future Exposure is Significantly Reduced	Compliance is Achievable	Effective	Reduction in TMV	Easily Implemented	1 Million	Acceptable	Acceptable

Preferred alternative is shaded.

a Based on 30-year present-worth cost.

b A groundwater monitoring network would be established to assure that there is no significant contaminant migration and that the rate of contaminant degradation is acceptable. Allowable concentrations of compounds of concern will be determined by the State of California during long-term groundwater monitoring.

c Reduction in TMV of groundwater contaminants will depend on natural attenuation and degradation of contaminants.

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SUMMARY OF ALTERNATIVES-
DIESEL SPILL AREA
SOIL AND GROUNDWATER

FIGURE 2-38

TABLE 2-28

SOIL REMEDIATION LEVELS
PAINT SHOP SUBSITE

Constituent	Remediation Level (mg/kg)	Basis for Remediation Level
1,2-Dichlorobenzene	None	See footnote [a]
1,3-Dichlorobenzene	None	See footnote [a]
1,4-Dichlorobenzene	980	Cancer Risk = 10^{-6}
Tetrachloroethene	None	See footnote [a]
Toluene	None	See footnote [a]
Xylenes	None	See footnote [a]
2-Chlorophenol	None	See footnote [a]
2,4-Dimethylphenol	None	See footnote [a]
Hexachloroethane	None	See footnote [a]
3-Methyl-4-Chlorophenol	None	See footnote [a]
4-Methylphenol	None	See footnote [a]
Phenol	None	See footnote [a]
1,2,4-Trichlorobenzene	None	See footnote [a]
Acenaphthene	None	See footnote [a]
Benzo[k]fluoranthene	0.25	Cancer Risk = 10^{-6}
Fluoranthene	None	See footnote [a]
2-Methylnaphthalene	None	See footnote [a]
Phenanthrene	None	See footnote [a]
Pyrene	None	See footnote [a]
Di-n-butylphthalate	None	See footnote [a]
bis(2-ethylhexyl)phthalate	None	See footnote [a]
Arsenic	None	Not detected above background

[a] This compound does not have a remediation level because it does not pose a risk at the site, according to the baseline risk assessment.

The baseline risk assessment (Montgomery Watson, 1993a) indicates an RME cancer risk estimate of 6E-06 and an RME hazard index of 1E-01 for the future construction worker. The primary contributor to the elevated cancer risk is 1,4-dichlorobenzene. Other contributing compounds for the cancer risk include benzo(k)fluoranthene and arsenic. Non-cancer risks are below the health-based remediation benchmark of one; therefore, current levels in soil would not pose a noncancer risk to future construction workers. Cleanup levels are presented for 1,4-dichlorobenzene and benzo(k)fluoranthene in Table 2-28. Although arsenic contributed to baseline cancer risk, there is no cleanup level for arsenic since the arsenic levels detected in soil are below background levels. No remediation levels are presented for the other COCs because these compounds do not contribute to cancer and/or noncancer risk in the baseline risk assessment. It should be noted that the health-based remediation levels presented in Table 2-28 are also considered protective of groundwater quality. Furthermore, these remediation levels are enforceable because they are included in this ROD/RAP. However, to the extent consistent with state law and CERCLA Section 120(a)(4), these levels could be altered at a later date if found to be technologically or economically infeasible.

Based on data presented in the 1992 Group I Follow-Up RI (Montgomery Watson, 1993a), all contaminant concentrations detected in soil at the Paint Shop Subsite are below calculated health-based remediation levels except for one sample. The 1,4-dichlorobenzene concentration detected in the 5-foot sample from boring TNT-20-SB (5,880 mg/kg) is above the calculated health-based remediation level for 1,4-dichlorobenzene based on the 10^{-6} cancer risk level (980 mg/kg). 1,4-Dichlorobenzene was not detected in any samples collected below the 5-foot interval. For cost-estimating purposes in the FS, it was assumed that soils at the Paint Shop Subsite would be excavated to a depth of 7.5 feet. The estimated volume of soils that would be excavated is 110 cubic yards (140 tons).

Implementation of the no-action alternative (Alternative 1) would not reduce contaminant concentrations. Therefore, the potential for future exposure remains. Although the institutional controls alternative (Alternative 2) would also not reduce contaminant concentrations, land use restrictions would be implemented to prevent exposure to potential future receptors. The off-site treatment and disposal alternative (Alternative 3) would reduce contaminant concentrations thereby significantly reducing the potential for future exposure. Because the soils currently pose no risk to ecological receptors, all of the alternatives are considered to provide protection to the environment. Additionally, soil contamination at the subsite currently does not pose a threat to groundwater; therefore, all of the alternatives are considered protective of groundwater quality. The soil remediation levels shown in Table 2-28 are considered protective of groundwater quality due to the site conditions. Groundwater is more than 55 feet below ground surface. Fine-grained layers, which act to retard the downward movement of chemicals in the soil, are present in the shallow subsurface beneath the site. Additionally, the site receives little precipitation and has relatively high rates of evaporation, which further inhibits the transport of chemicals downward through the soil column.

2.8.1.2 TNT Leaching Beds Subsite Soil. The baseline risk assessment determined that potential cancer risks to current intermittent workers and future construction workers are acceptable according to current USEPA and DTSC guidelines. Estimated noncancer health

effects for the current intermittent workers are considered acceptable according to current USEPA and DTSC guidelines. However, estimated noncancer health effects for potential future construction workers are considered unacceptable. The primary compounds contributing to these risks are 2,4,6-TNT and RDX. The baseline risk assessment concluded that the contaminated leaching beds soils pose minimal risk to ecological receptors due to the small areal extent of soil contamination.

Since estimated noncancer health effects for potential future construction workers are considered unacceptable, it is assumed for the excavation/treatment/disposal alternatives presented in the FS (Alternatives 3 and 4) that soils would be excavated to a depth below which untreated soils would not pose a cancer risk greater than 10^{-6} and a noncancer health index greater than 1.0 under a future construction worker scenario. To evaluate to what depth soils should be excavated for treatment and disposal, health-based remediation levels were calculated for subsurface soils using the same procedure used for the Paint Shop subsite soils (Table 2-29).

Based on the calculated remediation levels for subsurface soils, only the first 5 feet of soil in the leaching beds will require removal and treatment. For soils deeper than 5 feet, the cleanup levels for 2,4,6-TNT and RDX are not exceeded but subsurface concentrations of 2,4-DNT slightly exceed the cleanup level of 0.89 mg/kg at scattered depths. However, with the exception of one 10-foot soil sample, these soils are deeper than 12 feet, the maximum depth that a construction worker would be expected to excavate to. Therefore, excavation and treatment of soils deeper than 5 feet is not warranted. The estimated volume of soils in the leaching beds based on an excavation depth of 5 feet is 1,400 cy (1,800 tons).

However, not all surface soil containing explosives at the TNT Leaching Beds Subsite will be removed (low levels of explosives have been detected in surface soils outside of the leaching beds [Figure 2-20]). Therefore, to determine cleanup levels for these soils, the Army has examined the risk estimates for future residential exposures. The baseline risk assessment (JMM and E.C. Jordan, 1991b) indicates an RME cancer risk estimate of 2E-04 and an RME hazard index of 3E+01 for the future resident. The primary contributor to the elevated cancer risk is 2,4,6-TNT. Other contributing compounds for the cancer risk include RDX and 2,4-DNT. 2,4,6-TNT and 1,3,5-TNB contribute to the elevated non-cancer risk estimates. A summary of the cleanup levels for surface soils is presented in Table 2-29. Based on these cleanup levels, surface soils within an area northeast of the leaching beds will require remediation. The estimated volume of surface soils is 350 cubic yards (500 tons).

The remediation levels presented in Table 2-29 are enforceable because they are included in this ROD/RAP. However, these levels could be waived at a later date if found to be technically and/or economically infeasible.

It should be noted that the total baseline risk estimates used in calculating the cleanup levels for surface and subsurface soils at the TNT Leaching Beds Subsite do not include the risks calculated for dermal exposure (these values were presented in the baseline risk assessment included in the 1990 Phase I RI [JMM and E.C. Jordan, 1991b]). Risks due to dermal exposure are not included because guidance on calculating dermal risks was not available until 1991/1992

TABLE 2-29

SOIL REMEDIATION LEVELS
TNT LEACHING BEDS SUBSITE

Constituent	Remediation Level (mg/kg)	Basis for Remediation Level
Subsurface Soil		
2,4,6-Trinitrotoluene	800	Cancer Risk = 10^{-6}
RDX	56	Cancer Risk = 10^{-6}
1,3,5-Trinitrobenzene	None	See footnote [a]
HMX	None	See footnote [a]
2,4-Dinitrotoluene	0.89	Cancer Risk = 10^{-6}
Surface Soil		
2,4,6-Trinitrotoluene	40	Cancer Risk = 10^{-6}
RDX	2.8	Cancer Risk = 10^{-6}
1,3,5-Trinitrobenzene	2.9	HI = 1.0
HMX	None	See footnote [a]
2,4-Dinitrotoluene	0.05	Cancer Risk = 10^{-6}

[a] This compound does not have a remediation level because it does not pose a risk at the site, according to the baseline risk assessment.

after the risk assessment was performed. Furthermore, for the compounds detected in the leaching beds soils (i.e., explosives), it is expected that risks due to dermal exposure would be one to two orders of magnitude lower than for risks due to oral exposure. Therefore, the ingestion risk estimates are the primary contributors to overall risk.

It should be noted that based on the conditions found at this site, the Regional Board believes that the remediation levels calculated for the TNT Leaching Beds subsite soils will result in no further impact to groundwater. The site-specific conditions which lead the Regional Board to this conclusion are described in Section 2.8.1.1. Results of vadose zone modeling performed on the leaching beds indicate that soil contaminants will not migrate to groundwater at a significant rate (JMM and E.C. Jordan, 1991b). Current groundwater contamination at the site is considered the result of operation of the leaching beds in the 1940s which involved discharging large quantities of water to the beds.

Implementation of the no-action alternative (Alternative 1) would not reduce contaminant concentrations to below health-based remediation levels. Therefore, the potential for current and future exposure remains. Although the capping alternative (Alternative 2) would also not reduce contaminant concentrations to health-based remediation levels, it would prevent adverse exposure to current and potential future receptors thereby providing protection to humans and ecological receptors. The on-site composting alternative (Alternative 3) and the off-site treatment and disposal alternative (Alternative 4) would reduce contaminant concentrations to below health-based remediation levels thereby significantly reducing the potential for current and future exposure. Because the soils currently pose no risk to ecological receptors, all of the alternatives are considered protective of the environment. Additionally, soil contamination at the subsite currently does not pose a significant threat to groundwater; therefore, all of the alternatives are considered protective of groundwater.

2.8.1.3 TNT Leaching Beds Area Groundwater. There are no surface water bodies or other current potential exposure pathways for groundwater contamination at this site. The nearest water supply wells are SIAD's potable supply wells, which are approximately 1.5 miles south of the site. The baseline risk assessment determined that potential cancer risks and noncancer health effects to future residents are unacceptable according to current USEPA and DTSC guidelines. Compounds contributing to these risks are arsenic, TCE, carbon tetrachloride, chloroform, 1,2-DCA, 2,4-DNT, RDX, and 2,4,6-TNT. Exposure to arsenic via ingestion of groundwater is a contributor to cancer risk under a future residential scenario. However, arsenic was not detected above background in any groundwater samples collected at the TNT Leaching Beds Area. Therefore, all of the arsenic present in the groundwater is naturally occurring. Although a future residential exposure scenario was considered for the TNT Leaching Beds Area, the future resident is a highly unlikely scenario. Planned long-term land use for the site is ammunition renovation and storage which will prohibit residential and agricultural development. SIAD is an active facility and there are currently no plans for closure at SIAD. In the event of closure, the Army will re-evaluate the site for proposed reuse.

Under California's State Water Resources Control Board (SWRCB) Resolution No. 68-16 (the state's Antidegradation Policy), water quality may not be allowed to be degraded to below what is necessary to protect beneficial uses. This resolution applies most often at CERCLA cleanups that involve extracting, treating, and discharging treated groundwater. Any activities that result in discharges to high quality water are required to use the best practicable treatment or method of control of the discharge necessary to avoid a pollution or nuisance and to maintain water quality. Best practicable treatment would take into account technical and economic feasibility.

The Army believes that SWRCB Resolution 68-16 is applicable to reinjection of treated effluent but does not consider it applicable to degradation of groundwater caused by plume movement at the TNT Leaching Beds Area and Diesel Spill Area. The state believes that Resolution 68-16 is applicable to degradation of groundwater caused by plume movement and reinjection of effluent.

The Water Quality Control Plan for the Lahontan RWQCB ("Basin Plan") has designated groundwater at SIAD with the following beneficial uses: municipal and domestic supply, agricultural supply, and freshwater replenishment (Lahontan RWQCB, 1991). These beneficial uses apply to all groundwater. Therefore, shallow groundwater, in addition to all other groundwater, at SIAD must be protected as a potential source of drinking water even though the shallow groundwater is not currently used for potable supply. The following narrative water quality objectives listed in the Basin Plan pertain to groundwater at SIAD:

"Groundwaters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the limits specified in 22 CCR, Division 4, Chapter 15". [drinking water standards]

"Groundwaters shall not contain taste or odor-producing substances in concentrations that cause nuisance or adversely affect beneficial uses."

"Groundwaters designated for use as agricultural supply (AGR) shall not contain concentrations of chemical constituents in amounts that adversely affect such beneficial use."

SWRCB Resolution No. 92-49 requires that groundwater must be remediated in a manner that promotes attainment of background water quality or the best water quality which is reasonable if background concentrations cannot be achieved. If restoration to background water quality is technologically or economically infeasible, alternative cleanup levels can be established. Such alternative cleanup levels must (a) be consistent with the maximum benefit to the people of the state, (b) not unreasonably affect the present and anticipated beneficial uses of the water, (c) not result in water quality less than that prescribed in the Water Quality Control Plans and Policies adopted by the SWRCB and the Lahontan RWQCB, and (d) not exceed the lowest concentration that is technologically and economically achievable.

The Army agrees that SWRCB Resolution No. 92-49 requires the remediation of contaminated groundwater to the lowest levels that are technologically and economically feasible. Due to the experimental approach of the natural attenuation and degradation alternative, there are

uncertainties associated with determining what cleanup levels are achievable. Therefore, restoration of the groundwater to background concentrations will be considered by the Army to be a primary remedial objective of this ROD/RAP.

If during the implementation of the selected remedy, the Army believes that it is infeasible to meet the objective of remediation to background concentrations, the Army may demonstrate to the State that groundwater remediation to background is technologically or economically infeasible. To demonstrate remediation infeasibility, the Army shall submit a report which contains remediation data and other information supporting its claim. After the State receives the report, it will determine whether, or at what point, the Army may terminate its remediation efforts, or whether further remediation efforts are required. The concentrations specified in Table 2-30 are the contaminant concentrations that would protect the waters for their beneficial uses, which are the minimum standards (i.e., highest allowable concentrations) that would be protective of the applicable water quality objectives, i.e., "Protective Water Quality Objectives" (PWQOs). However, to the extent consistent with State law and CERCLA Section 120(a)(4), PWQOs could be altered to a less stringent standard at a later date if cleanup to the PWQOs is found to be technologically or economically infeasible. These PWQOs are discussed below.

The PWQOs contained in Table 2-30 were selected as follows: For those groundwater COCs that have drinking water standards, MCLs and secondary maximum contaminant levels (SMCLs) are the PWQOs (40 CFR Parts 141 and 143; 22 CCR Div. 4, Chapter 15, Sec. 64401 et seq). For TCE, the PWQO is 5 μg/l, which is based on the federal and California MCLs (Table 2-30). TCE is the primary contaminant driving remediation of the VOCs plume. For carbon tetrachloride and 1,2-dichloroethane, the PWQOs for both compounds is 0.5 μg/l (based on California MCLs) (Table 2-30). There are no federal or California MCLs for the explosives, and there are no SMCLs for any of the groundwater COCs at the TNT Leaching Beds Area.

For those groundwater COCs that do not have MCLs or SMCLs (i.e., explosives and chloroform), PWQOs are based on selected water quality levels published in "A Compilation of Water Quality Goals" (Central Valley RWQCB, 1993). PWQOs were selected from the Central Valley report based on the water quality objectives presented in the Basin Plan for the Lahontan Region. For those compounds with more than one applicable water quality goal presented in the Central Valley report, the most stringent level was selected. For those compounds where the most stringent levels are below the compounds' certified reporting limits (CRLs), the CRLs are listed as the PWQOs. It should be noted that the concentrations of nitrobenzene detected to date in the groundwater at the TNT Leaching Beds Area (4.38 μg/l to 4.66 μg/l) are below the PWQO of 17 μg/l.

Alternative 1 (no action) would not control exposure to groundwater or actively reduce groundwater contaminant concentrations. Therefore, the potential for future exposure to groundwater contamination remains. Because contaminated groundwater would not be available except through future installation of a supply well, the risk to environmental receptors is minimal at this site. Alternative 2 would depend upon natural attenuation and degradation to reduce contaminant concentrations. Institutional controls would be implemented to prevent future installation of water supply wells in the area of the site, thereby preventing possible adverse

TABLE 2-30

PROTECTIVE WATER QUALITY OBJECTIVES
TNT LEACHING BEDS AREA

Constituent	Protective Water Quality Objective (μg/l)	Basis for Protective Water Quality Objective
Trichloroethene	5	USEPA and California Primary MCL
Carbon tetrachloride	0.5	California Primary MCL
1,2-Dichloroethane	0.5	California Primary MCL
Chloroform	1.1/0.43	Cal EPA cancer potency factor as a Water Quality Criterion (based on 10^{-6} cancer risk)
1,3,5-Trinitrobenzene	40	USEPA Health Advisory (HA) based on systemic toxicity
RDX	1.2	Certified Reporting Limit
2,4-Dinitrotoluene	0.06	Certified Reporting Limit
2,6-Dinitrotoluene	0.07	Certified Reporting Limit
2,4,6-Trinitrotoluene	0.6	Certified Reporting Limit
Nitrobenzene	17	USEPA National Ambient Water Quality Criterion Non-Cancer Public Health Effects

human exposure to groundwater contaminants. Under Alternative 2, the deeper aquifer zones may be protected from future contamination since groundwater monitoring results indicate that contaminants from the "A" zone may not be migrating vertically. Furthermore, it is unlikely that the "A" zone of the aquifer will be used for water supply even without institutional controls in place. Potable supply wells installed at other areas of the basin are generally screened at depths greater than the "A" zone of the aquifer because of the poor quality of the "A" zone water. The potable supply wells currently installed at SIAD are screened from approximately 150 to 650 feet bgs. As with Alternative 1, the potential risks to ecological receptors are expected to be minimal for Alternative 2. Due to the experimental approach of the natural attenuation and degradation alternative, there are uncertainties associated with this alternative's potential to achieve remediation levels within a reasonable timeframe.

The pump-and-treat alternatives (Alternative 3, 4, and 5) involve active treatment of the groundwater. Therefore, these alternatives could potentially reduce contaminant concentrations to below remediation levels thereby significantly reducing potential future exposure. However, the limitations of pump-and-treat systems are discussed in the following USEPA report: <u>Guidance for Evaluating the Technical Impracticability of Ground-Water Restoration</u>, (September 1993). In this report, USEPA states: "While both programs [Superfund and RCRA Corrective Action] have had a great deal of success reducing the immediate threats posed by contaminated groundwaters, experience over the past decade has shown that restoration to drinking water quality (or more stringent levels where required) may not always be achievable due to the limitations of available remediation technologies." As discussed previously, Alternative 4 (Groundwater Extraction and Treatment with Air Stripping and GAC Adsorption) is the contingency alternative for the selected remedy (Alternative 2).

2.8.1.4 Diesel Spill Area Soil and Groundwater. As discussed in Section 2.6, there are no current or potential future exposure pathways for the Diesel Spill Area. However, diesel-related compounds in the soil are above the state-recommended cleanup level of 100 mg/kg for TPH. As discussed in Section 2.8.1.3, a primary goal of this remediation effort is to restore the groundwater to background concentrations. If the Army chooses to demonstrate to the State that remediation to the background concentration is technologically or economically infeasible, the Army may submit a report which contains remediation data and other information supporting its claim. After the State receives the report, it will determine whether, and at what point, the Army may terminate its remediation efforts, or whether further remediation efforts are required. A USEPA Suggested No-Adverse-Response-Level (SNARL) for diesel based on systemic toxicity of 100 μg/l is the PWQO and may be considered as minimally protective of the waters for their beneficial uses pursuant to SWRCB Resolution No. 92-49. However, it should be noted that this SNARL is based on short-term (10-day) exposure. TPH-diesel was detected in groundwater at the Diesel Spill Area at concentrations of 820 μg/l and 850 μg/l in two HydroPunch samples collected in November 1993 (Figure 2-28). Remediation levels for the Diesel Spill Area are presented in Table 2-31. The primary groundwater remediation objective and the soil remediation level are enforceable because they are included in this ROD/RAP. However, to the extent consistent with State law and CERCLA Section 120(a)(4), the PWQO and the soil remediation level could be altered at a later date if found to be technologically or economically infeasible. It should be noted that based on the conditions found

TABLE 2-31

SOIL REMEDIATION LEVEL AND PROTECTIVE WATER QUALITY OBJECTIVE
DIESEL SPILL AREA

Constituent	Soil Remediation Level (mg/kg)	Protective Water Quality Objective (μg/l)	Basis for Soil Remediation Level and Protective Water Quality Objective
TPH-Diesel	100		State of California Recommended Cleanup Level
		100	USEPA Suggested No-Adverse-Response-Level (SNARL)

at this site, the Regional Board believes that the remediation level for the Diesel Spill Area soils will result in no further impact to groundwater. The site-specific conditions which lead the Regional Board to this conclusion are describedin Section 2.8.1.1.

Alternative 1 (no action) would not reduce soil contaminant concentrations to the state-recommended cleanup level and would not actively reduce groundwater contaminant concentrations. Therefore, the potential for future exposure remains. Although the bioventing and natural attenuation and degradation alternative (Alternative 2) would also not actively reduce contaminant concentrations, institutional controls would be implemented to prevent future installation of water supply wells in the area of the site. Alternatives 3, 4, 5, and 6 would actively reduce contaminant concentrations thereby reducing the potential for future exposure. Although, as discussed for the TNT Leaching Beds Area groundwater in Section 2.8.1.3, USEPA (1993) states: "While both programs [Superfund and RCRA Corrective Action] have had a great deal of success reducing the immediate threats posed by contaminated groundwaters, experience over the past decade has shown that restoration to drinking water quality (or more stringent levels where required) may not always be achievable due to the limitations of available remediation technologies."

2.8.2 Compliance with Applicable or Relevant and Appropriate Requirements

SIAD is not on the National Priorities List (NPL). Pursuant to CERCLA §120(a)(4), remedial actions at non-NPL sites must comply with all state laws regarding removal or remedial actions. Further, the Army, as the lead agency, must select a remedial action which complies with CERCLA §121(d)(1). Pursuant to CERCLA §121(d)(1), remedial actions must attain a degree of cleanup that assures protection of human health and the environment. Additionally, remedial actions that leave hazardous substances, pollutants, or contaminants on site must meet standards, requirements, limitations, or criteria that are ARARs. Federal ARARs for any site may include requirements under any federal environmental laws. State ARARs include promulgated requirements under state environmental or facility-siting laws that are more stringent than any federal ARARs and that have been identified by the state in a timely manner.

Applicable requirements are those cleanup standards, control standards, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location or other circumstances at a CERCLA site.

Relevant and appropriate requirements are defined as those cleanup standards of control and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that although not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location or other circumstance at a CERCLA site, indicate that their use is well-suited to the particular site. If no ARAR addresses a particular situation, or if an ARAR is insufficient to protect human health or the environment, then non-promulgated standards, criteria, guidance, and advisories may be used to provide a protective remedy.

To the extent consistent with CERCLA and the NCP, the Army is not required to obtain federal, state, or local permits for those portions of the remedial actions conducted entirely onsite, but need only comply with the substantive, not procedural, provisions which would have been included in any such permit.

CERCLA §121 states that, at the completion of a remedial action, a level or standard of control required by an ARAR will be attained for wastes that remain on site. In addition, the NCP, 40 CFR 300.435(b)(2), requires compliance with ARARs during the course of the remedial design/remedial action.

ARARs are identified on a site-specific basis from information about specific chemicals at the site, specific actions that are being considered as remedies, and specific features of the site location. There are three types of ARARs:

- Chemical-specific ARARs are health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. If a chemical has more than one ARAR, the most stringent value will be complied with.

- Location-specific ARARs are restrictions placed on the concentration of a chemical or the activities to be conducted solely because they are in a specific location. Examples of special locations possibly requiring location-specific restrictions include floodplains, wetlands, historic places, and sensitive ecosystems or habitats.

- Action-specific ARARs are usually technology- or activity-based restrictions or requirements for remedial actions. These ARARs do not determine the remedial alternative to be applied at a site; rather, they indicate how a selected alternative will be implemented. The potential action-specific ARARs will vary depending on the remedial alternatives selected for the sites.

Where no standards exist for a given chemical or situation, nonpromulgated advisories and guidance issued by the state or federal government programs may represent "to be considered" (TBC) criteria or guidelines in the RI/FS process. Although TBC requirements are not legally binding, they may be evaluated along with ARARs as part of the risk assessment to establish protective target clean-up levels.

The following sections discuss the ARARs that were considered for the TNT Leaching Beds Area and Diesel Spill Area. A listing of federal and state laws that are ARARs is provided in Tables 2-32 and 2-33.

TABLE 2-32

APPLICABLE OR RELEVANT AND APPROPRIATE FEDERAL REQUIREMENTS FOR SIAD

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comment
Chemical Specific				
Safe Drinking Water Act	40 U.S.C. §300			
National Primary Drinking Water Standards	40 C.F.R. Part 141	Establishes health-based standards for public water systems (Maximum Contaminant Levels [MCLs] and Maximum Contaminant Level Goals [MCLGs]).	Relevant and appropriate	Not applicable but are relevant and appropriate if groundwater becomes a drinking water source. The MCLs and non-zero MCLGs are applicable at the tap, and relevant and appropriate for a drinking water source.
National Secondary Drinking Water Standards	40 C.F.R. Part 143	Establishes aesthetic- or organoleptic-based standards for public water systems (Secondary Maximum Contaminant Levels [SMCLs]). No SMCLs have been established for the chemicals of concern.	Applicable	SMCLs are applicable because the Basin Plan for the RWQCB includes the narrative standards for taste and odor.
Action Specific				
Clean Water Act	33 U.S.C. §§1251-1376	Water quality criteria are provided for "from drinking water and from consuming aquatic organisms."	Relevant and appropriate	Relevance and appropriateness of water quality criterion depends on the likely routes of exposure. RWQCB will utilize these criteria in setting effluent discharge requirements.
Underground Injection Control Regulations	40 C.F.R. Parts 144-147	Provides for protection of underground sources of drinking water.	Relevant and appropriate	A permit is not required for on-site CERCLA response actions, but substantitive requirements would apply for alternatives that involve underground injection.

TABLE 2-33

APPLICABLE OR RELEVANT AND APPROPRIATE CALIFORNIA REQUIREMENTS FOR SIAD
(1 of 6)

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comment
Mulford-Carrell Air Resources Act	H & S Code, Div. 26, §39000 et seq. CCR, Title 17, Part III, Chapter 1, §60000 et seq.	Regulates both nonvehicular and vehicular sources of air contaminants in California. Defines relationships of the California Air Resources Board (ARB) and local or regional air pollution control districts (APCDs). Establishes emission limitations.	Applicable	The local APCD sets allowable emission limits. Emission limits will need to be established for emissions associated with specific remedial alternatives. SIAD is located in Lassen County. Applicable air quality regulations are specified in the Lassen County Air Pollution Control District's Air Pollution Regulations. The Lassen County APCD determines emission limits on a site-specific basis. CA Regulatory Agency: ARB; Lassen County APCD
California Safe Drinking Water Act	H & S Code, Div. 5, Part 1, Chapter 7, §4010 et seq. CCR, Title 22, Div. 4, Chapter 15, §64401 et seq.	Regulations governing public water systems. Drinking Water Quality Standards - MCLs, SMCLs. Requirements for water quality analysis and laboratories.	Relevant and appropriate	The act is legally applicable for an aquifer and associated distribution and pre-treatment system that is currently defined as a "public Water system." If an aquifer, and associated distribution and pre-treatment system is only a potential "public water system," then the act is relevant and appropriate MCLs are acceptable concentration limits from a "free flowing coldwater outlet of the ultimate user." To apply this standard as a cleanup level for groundwater means the law, and the standard, is relevant and appropriate. CA Regulatory Agency: DHS, Water Supply Branch

TABLE 2-33

APPLICABLE OR RELEVANT AND APPROPRIATE CALIFORNIA REQUIREMENTS FOR SIAD

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comment
Discharges of Waste to Land	CCR, Title 23, Division 3, Chapter 15, §2500 et seq.	Regulations pertaining to waste discharges to land that may threaten water quality: design and construction standards for waste management units that minimize threats to waters of the state; classification of wastes based on their intrinsic threat to water quality and discharge site conditions. Wastes must be discharged for treatment, storage, or disposal to waste management units classified according to the ability to contain types of waste being discharged. Additional waste management unit (WMU) requirements also specified.	See comment	The Army and State of California have agreed to disagree on the legal interpretations of Chapter 15. The Army believes that Chapter 15 is an action-specific ARAR for the ROD/RAP that applies to discharges of waste to land resulting from implementation of remedial alternatives. The State believes that Chapter 15 applies to cleanups where past activities have resulted in discharges of waste to land as well as the redisposal of waste. The Army and State have agreed that the cleanup levels proposed in this ROD/RAP are protective of water quality, human health, and ecological receptors and, therefore satisfy the water quality requirements of Chapter 15. CA Regulatory Agency: RWQCB, State Water Resources Control Board

TABLE 2-33

APPLICABLE OR RELEVANT AND APPROPRIATE CALIFORNIA REQUIREMENTS FOR SIAD
(3 of 6)

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comment
Water Quality Protection Standards	CCR, Title 23, Division 3, Chapter 15, Article 5, §2550.12	Establishes water quality protection standards including concentration limits for constituents of concern at background levels. Cleanup levels above background must meet all applicable water quality standards and must be the lowest levels technologically and economically achievable. Corrective action programs are required to achieve compliance with the water quality protection standards.	Applicable	As determined by RWQCB CA Regulatory Agency: RWQCB; State Water Resources Control Board
Porter Cologne Water Quality Control Act	California Constitution, Article X. Water Sec. 2. Water Resource. California Water Code: Div. 1, Chapt. 2.5, Art. 3; Div. 7, Chapt. 1, 2; Chapt. 3, Art. 3; Chapt. 3, Art. 4, §§13160, 13170, 13170.1, 13170.2, 13172; Chapt. 4, Art. 2, §§13225, 13226, 13227; Chapt. 4, Art. 3, §§13240, 13241, 13242, 13243, 13247; Chapt 4, Art. 4, §§13260, 13261, 13263, 13265, 13267, 13268, 13273, 13273.2, 13273.3; Chapt. 5, Art. 1, §§13301, 13304; Chapt. 5, Art. 1, §§13301, 13304; Chapt. 5, Art. 6, §13360; Chapt. 5.5	Authorizes the State and Regional Water Boards to establish in Water Quality Control Plans beneficial uses and numerical and narrative standards to protect both surface and groundwater quality. Authorizes Regional Water Boards to issue permits for discharges to land or surface or groundwater that could affect water quality, including National Pollution Discharge Elimination System (NPDES) permits, and to take enforcement action to protect water quality. Implemented through regulations (Title 23 CCR), plans, policies and guidelines.	Applicable	The RWQCB will determine specific cleanup standards. The RWQCB will identify any other promulgated requirements which apply to the proposed remedial alternatives. CA Regulatory Agency: RWQCB; State Water Resources Control Board

TABLE 2-33

APPLICABLE OR RELEVANT AND APPROPRIATE CALIFORNIA REQUIREMENTS FOR SIAD
(4 of 6)

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comment
Policies and Procedures for Investigation, Cleanup, and Abatement of Discharge under Water Code Section 13304	State Water Resources Control Board Resolution No. 92-49 California Water Code: §§13140, 13240, 13260, 13263, 13267, 13300, 13304, 13307	Establishes requirements for investigation, cleanup, and abatement of discharges. Among other requirements, discharges must clean up and abate the effects of discharges in a manner that promotes the attainment of either background water quality, or the best water quality that is reasonable if background water quality cannot be restored. Requires the application of Title 23, CCR, Div. 3, Ch. 15 requirements to cleanups.	Applicable	CA Regulatory Agency: RWQCB; State Water Resources Control Board
Water Quality Control Plans	Water Code, Div. 7, §13140, §13240	Each Regional Board promulgates and administers a Water Quality Control Plan for ground and surface water basin(s) within its region. The State Board also promulgates state-wide water quality control plans that the regional boards administer. The Plans establish water quality standards (including beneficial use designations, water quality objectives to protect those uses, and implementation programs to meet the objectives) that apply statewide or to specific water basins.	Applicable	Regional Water Quality Objectives are identified in the Water Quality Control Plan Reports (Basin Plans) of the nine RWQCBs. Used to set discharge standards for NPDES permits and Waste Discharge Requirements (WDRs). These criteria may be applicable depending on the remedial alternative chosen. CA Regulatory Agency: RWQCB, State Water Resources Control Board

TABLE 2-33

APPLICABLE OR RELEVANT AND APPROPRIATE CALIFORNIA REQUIREMENTS FOR SIAD
(5 of 6)

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comment
State Water Resources Control Board Antidegradation Policy	State Water Resources Control Board Resolution No. 68-16	The State Board's policy on maintaining the high quality of California's waters.	See comment	The RWQCB establishes aquifer cleanup levels and effluent treatment standards for groundwater based upon this policy. The Army believes that SWRCB Resolution 68-16 is applicable to reinjection of treated effluent but does not consider it applicable to degradation of groundwater caused by plume movement at the TNT Leaching Beds Area and Diesel Spill Area. The state believes that Resolution 68-16 is applicable to degradation of groundwater caused by plume movement and reinjection of effluent. CA Regulatory Agency: RWQCB; State Water Resources Control Board
Drinking Water Source Definition	State Water Resources Control Board Resolution No. 88-63 (included in Water Quality Control Plan for RWQCB Lahontan Region)	Specifies that all ground and surface waters are existing or potential sources of drinking water unless total dissolved solids (TDS) are greater than 3,000 ppm, the well yield is less than 200 gpd from a single well or the groundwater is unreasonable to treat using Best Management Practices or best economically achievable treatment practices.	Applicable	CA Regulatory Agency: RWQCB; State Water Resources Control Board

TABLE 2-33

APPLICABLE OR RELEVANT AND APPROPRIATE CALIFORNIA REQUIREMENTS FOR SIAD
(6 of 6)

Standard, Requirement, Criterion, or Limitation	Citation	Description	Applicable or Relevant and Appropriate	Comment
Hazardous Waste Control Laws	H & S Code, Div. 20, Chapters 6.5 and 6.8, §25100 et seq. CCR Title 22, Div. 4.5, Chapter 10, §66001 et seq.	Regulations governing hazardous waste control; management and control of hazardous waste facilities; transportation; laboratories; classification of extremely hazardous, hazardous, and nonhazardous waste. Includes STLCs and TTLCs.	Applicable or relevant and appropriate	State hazardous waste control laws are considered applicable or relevant and appropriate operating standards for those alternatives involving treatment and disposal of hazardous wastes. CA Regulatory Agency: Department of Toxic Substances Control
Identification and Listing of Hazardous Waste (Hazardous Substance Act)	CCR, Title 22, Div. 4.5, Chapter 11, §66261 et seq.	Definitions and characteristics of waste, hazardous waste, RCRA hazardous waste and special waste. Labeling requirements.	Applicable	This Act applies to ongoing operations of a facility that processes hazardous materials or wastes. CA Regulatory Agency: DTSC
Health and Safety Standards for Management of Hazardous Waste	CCR, Title 22, Div. 4.5, Chapt. 14, Art. 16, §§66264.600-66264.603	Applies to owners and operators of facilities that treat, store or dispose of RCRA hazardous waste in miscellaneous units. Covers environmental performance standards, monitoring, inspections, and post-closure care.	Relevant and Appropriate	Some of the alternatives will utilize treatment systems that are considered miscellaneous units. CA Regulatory Agency: DTSC
	CCR, Title 22, Div. 4.5, Chapt. 14, Art. 9, §§66264.170-66264.178	Applies to owners and operators who store hazardous waste for more than 90 days in containers. Covers use and management of containers, containment, inspections, and closure.	Relevant and Appropriate	CA Regulatory Agency: DTSC

2.8.2.1 Paint Shop Subsite Soil

Chemical-Specific ARARs. There are no California or federal chemical-specific ARARs for any of the compounds detected in soil at the Paint Shop Subsite.

Location-Specific ARARs. The Army has not identified any location-specific ARARs for the Paint Shop Subsite.

Action-Specific ARARs. 23 CCR Division 3 contains regulations adopted by the State Water Resources Control Board for the purpose of implementing certain provisions of the California Water Code. Chapter 15 of 23 CCR Division 3 ("Chapter 15") contains regulations governing discharges of waste to land where water quality could be adversely impacted. Chapter 15 regulations govern the discharge of waste to land for treatment, storage, and disposal and establish siting, containment, monitoring, and closure standards. Activities included in this program are the issuance of waste discharge requirements (WDRs) by the Regional Water Quality Control Boards for the discharge of hazardous, designated, and nonhazardous solid wastes to land and the oversight of corrective actions at leaking waste management units. Cleanup activities involving the discharge of waste to land or the closure of leaking waste management units at a CERCLA site would be subject to the substantive requirements of Chapter 15. SWRCB Resolution No. 92-49 requires actions to clean up discharges of waste to comply with Chapter 15. Therefore, corrective action, closure, and other requirements of Chapter 15 are applicable to CERCLA cleanups, not just to cleanups involving waste management units.

The Army and State of California have agreed to disagree on the legal interpretations of Chapter 15. The Army believes that Chapter 15 is an action-specific ARAR for the ROD/RAP that applies to discharges of waste to land resulting from implementation of remedial alternatives. The State believes that Chapter 15 applies to cleanups where past activities have resulted in discharges of waste to land as well as the redisposal of waste. The Army and State have agreed that the cleanup levels proposed in this ROD/RAP are protective of water quality, human health, and ecological receptors and, therefore, satisfy the water quality requirements of Chapter 15.

California SWRCB Resolution 92-49 establishes policies and procedures for the oversight of investigations and cleanup and abatement activities resulting from discharges that affect or threaten water quality. However, the scope of Water Code §13304 is limited by §13304(f) which states, "This section [13304] does not impose any new liability for acts occurring before January 1, 1981, if the acts were not in violation of existing laws or regulations at the time they occurred." SWRCB Resolution 92-49 requires actions for cleanup and abatement to conform to SWRCB Resolution 68-16 and State and Regional Water Board Water Quality Control Plans (Basin Plans) and Policies. Cleanup levels are not required to be more stringent than background. Cleanup levels and effluent discharge limitations need not be identical for the same site. However, as the Army does not believe that the provisions of SWRCB Resolution 68-16 are triggered by the movement of contaminants within the plume, the Army does not consider SWRCB Resolution 68-16 to be an ARAR for any of the proposed groundwater remediation actions not involving reinjection. SWRCB Resolution 92-49 is considered an ARAR for SIAD.

Additional action-specific ARARs for all of the alternatives include state hazardous waste management regulations (CCR Title 22), and state and federal occupational health and safety regulations (Table 2-33).

To Be Considered Criteria. The health-based cleanup levels that have been calculated for the Paint Shop Subsite soils are TBCs.

Compliance with ARARs. All of the alternatives are in compliance with ARARs.

2.8.2.2 TNT Leaching Beds Subsite Soil

Chemical-Specific ARARs. There are no California or federal chemical-specific ARARs for any of the compounds detected in soil at the TNT Leaching Beds Subsite.

Location-Specific ARARs. The Army has not identified any location-specific ARARs for the TNT Leaching Beds Subsite.

Action-Specific ARARs. Potential action-specific ARARs for all of the alternatives include waste discharge requirements (23 CCR Div. 3, Chapter 15), state hazardous waste management regulations (CCR Title 22), and state and federal occupational health and safety regulations (Table 2-33). 23 CCR Div. 3, Chapter 15, Articles 4, 5, and 8 list specific requirements for construction, monitoring, and closure of waste piles that apply to Alternative 3 (Composting). The wastes will be characterized according to Article 2, and discharged to a waste pile constructed in accordance with Article 4. As discussed in Section 2.8.2.1, SWRCB Resolution 92-49 is an ARAR for SIAD.

To Be Considered Criteria. The health-based cleanup levels developed for soils at the TNT Leaching Beds Subsite are TBCs.

Compliance with ARARs. Alternatives 1 and 2 would not reduce soil contaminant concentrations to below calculated health-based cleanup levels. However, these levels are not ARARs and are not legally enforceable. Alternatives 3 and 4 would utilize treatment to reduce contaminant concentrations to below health-based cleanup levels.

2.8.2.3 TNT Leaching Beds Area Groundwater

Chemical-Specific ARARs. As discussed in Section 2.8.1.3, SWRCB Resolution No. 92-49 has been used to develop the protective water quality objectives presented in Table 2-30. Of the compounds of concern in groundwater at the TNT Leaching Beds Area, there are state and federal MCLs for TCE, carbon tetrachloride, and 1,2-dichloroethane but there are no MCLs for any of the explosives compounds or chloroform. There are no SMCLs for any of the COCs. For those compounds that do not have MCLs or SMCLs (i.e., explosives and chloroform), the protective water quality objectives are based on health-based guidance levels published in Central Valley RWQCB (1993). The health-based guidance levels are TBCs.

Location-Specific ARARs. The Army has not identified any location-specific ARARs for the TNT Leaching Beds Area groundwater.

Action-Specific ARARs. As required by the California Porter-Cologne Water Quality Act, the Lahontan RWQCB defines the beneficial uses of various water bodies for the Herlong Hydrologic Subunit which includes SIAD. Water bodies and their beneficial uses are presented in the Basin Plan. The Basin Plan classifies aquifers at SIAD to have "existing or potential beneficial uses as sources of drinking water." The Basin Plan has been promulgated and portions thereof are ARARs with respect to SIAD. The identification of the beneficial use of the groundwater at SIAD serves as the basis for selection of maximum COC concentrations for cleanup of groundwater pursuant to SWRCB Resolution No. 92-49. As discussed in Section 2.8.1.3, SWRCB Resolution 92-49 requires that groundwater must be remediated to the lowest levels that are technologically and economically achievable. Due to the experimental approach of the natural attenuation and degradation alternative and due to the fact that sufficient data have not yet been developed to support a conclusion that levels other than background are appropriate for this site, there are uncertainties associated with determining what levels are achievable. Therefore, restoration of the groundwater to background concentrations will be considered by the Army to be a primary remedial objective of this ROD/RAP. If during the implementation of the selected remedy, the Army believes that it is infeasible to meet the objective of remediation to background concentrations, the Army shall demonstrate to the State that groundwater remediation to background is technologically or economically infeasible. To demonstrate remediation infeasibility, the Army may submit a report which contains remediation data and other information supporting its claim. After the State receives the report, it will determine whether, or at what point, the Army may terminate its remediation efforts, or whether further remediation efforts are required.

Treatment ARARs:

Use of activated carbon for remediation of VOCs and explosives under Alternatives 3 and 4 could trigger requirements associated with regeneration or disposal of the spent carbon. If the spent carbon is listed waste or a characteristic waste then it is regulated as a hazardous waste under California's Hazardous Waste Management (HWM) regulations (22 CCR §§66262.10 - 66262.57).

Containers used for storage of contaminated carbon that is classified as a listed or characteristic waste must comply with California HWM regulations (22 CCR §§66262.30 - 66262.33). Accumulation of hazardous waste on site for more than 90 days may trigger the requirements set forth in California HWM regulations (22 CCR §66264).

Disposal of contaminants can trigger California HWM land disposal restrictions. If land disposal restrictions are triggered, spent carbon would need to meet treatment standards and California HWM disposal regulations.

Discharge ARARs:

Surface water is not impacted as a result of groundwater contamination at SIAD and none of the alternatives include discharge to surface water. In the event that the contingency alternative is implemented, the Army will work with the State of California who will develop substantive waste discharge requirements for the disposal of treated groundwater. Those substantive waste discharge requirements will be based on SWRCB Resolution No. 68-16, and specify the appropriate effluent discharge standards, monitoring programs, and other relevant performance criteria.

As shown in Table 2-33, nonvehicular sources of air contaminants in California are regulated under the Mulford-Carrell Air Resources Act. This Act defines the relationships of the California Air Resources Board and local or regional air pollution control districts (APCDs). According to the Lassen County Air Pollution Control District, a complete inventory of secondary air emissions will be required to determine if treatment of vapor emissions from an air stripper will be required at SIAD (Smith, 1994). However, it is anticipated that treatment of air emissions will not be required due to the small volume of VOCs expected to be generated. Therefore, treatment of air emissions was included in Alternative 4 as a conservative measure.

Additional action-specific ARARs for all of the alternatives include state and federal occupational health and safety regulations.

To Be Considered Criteria. Non-promulgated health-based water quality criteria used as remediation levels are TBCs.

Compliance with ARARs. Alternatives 1 and 2 would depend upon natural attenuation and degradation to reduce groundwater contaminant concentrations to below remediation levels. As discussed in Section 2.7.3.2, a groundwater monitoring network would be established to evaluate compliance. The pump-and-treat alternatives (Alternatives 3, 4, and 5) would utilize treatment to reduce contaminant concentrations to below remediation levels.

2.8.2.4 Diesel Spill Area Soil and Groundwater

Chemical-Specific ARARs. As discussed in Section 2.8.1.4, narrative water quality objectives presented in the Basin Plan for groundwater at SIAD have been used to develop the protective water quality objective for the Diesel Spill Area (Table 2-31). The protective water quality objective for TPH-diesel (100 μg/l) is based on a SNARL developed by USEPA. The SNARL for diesel is a TBC.

Location-Specific ARARs. The Army has not identified any location-specific ARARs for the Diesel Spill Area.

Action-Specific ARARs. Action-specific ARARs for alternatives developed for the Diesel Spill Area soil and groundwater are discussed below.

As discussed in Section 2.8.1.4, SWRCB Resolution 92-49 is an ARAR for the remediation action proposed at this site. SWRCB Resolution 92-49 requires that groundwater must be remediated to the lowest levels that are technologically and economically achievable. Due to the experimental approach of the natural attenuation and degradation alternative and due to the fact that sufficient data have not yet been developed to support a conclusion that levels other than background are appropriate for this site, there are uncertainties associated with determining what levels are achievable. Therefore, restoration of the groundwater to background concentrations will be considered by the Army to be a primary remedial objective of this ROD/RAP. If during the implementation of the selected remedy, the Army believes that it is infeasible to meet the objective of remediation to background concentrations, the Army may demonstrate to the State that groundwater remediation to background is technologically or economically infeasible. To demonstrate remediation infeasibility, the Army shall submit a report which contains remediation data and other information supporting its claim. After the State receives the report, it will determine whether, or at what point, the Army may terminate its remediation efforts, or whether further remediation efforts are required.

Treatment ARARs:

As discussed in Section 2.8.2.3, activated carbon generated from treatment of groundwater may trigger California's HWM regulations (22 CCR §§66262.10-66262.57).

Discharge ARARs:

Surface water is not impacted as a result of groundwater contamination at SIAD and none of the alternatives include discharge to surface water. For those alternatives involving reinjection of treated groundwater, the Army would work with the State of California who would develop substantive waste discharge requirements for the disposal of treated groundwater. Those substantive waste discharge requirements would be based on SWRCB Resolution No. 68-16, and would specify the appropriate effluent discharge standards, monitoring programs, and other relevant performance criteria.

As discussed in Section 2.8.2.3, the Lassen County APCD will assess the need for emissions control on a site-specific basis. However, it is anticipated that treatment of air emissions will not be required due to the small volume of VOCs expected to be generated (the VOC fraction of weathered diesel is very low). Therefore, treatment of air emissions was included as a conservative measure in some alternatives.

Additional action-specific ARARs for all of the alternatives include waste discharge requirements in CCR Title 23 Chapter 15, and state and federal occupational health and safety regulations. As discussed in Section 2.8.2.1, SWRCB Resolution No. 92-49 is an ARAR for SIAD.

To Be Considered Criteria. DTSC has indicated that a soil cleanup level of 100 mg/kg for TPH is appropriate for the Diesel Spill Area. The 100 mg/kg cleanup level for TPH is not promulgated; therefore, it is not an ARAR but a TBC. Since the SNARL for diesel is not promulgated, it is a TBC.

Compliance with ARARs. Alternatives 1 and 2 would not actively reduce diesel-related compound concentrations in soil to below the 100 mg/kg cleanup level for TPH. The 100 mg/kg cleanup level for TPH has been set to comply with SWRCB Resolution No. 92-49 and Chapter 15 and is legally enforceable through this ROD/RAP. Alternatives 3 through 6 would utilize in situ bioventing to actively reduce TPH-diesel concentrations in soil to below the 100 mg/kg remediation goal.

Alternatives 3 and 4 would use groundwater extraction and treatment to actively remove contaminants from groundwater. However, as discussed for the TNT Leaching Beds Area groundwater, these pump-and-treat alternatives are expected to take a very long time (over 50 years) to achieve site restoration. Alternatives 5 and 6 involve in situ treatment of groundwater and are expected to be more successful in remediating groundwater at the Diesel Spill Area.

2.8.3 Long-Term Effectiveness and Permanence

Long-term effectiveness and permanence refers to the ability of a remedy to maintain reliable protection of human health and the environment over time. This criterion includes the consideration of residual risk and the adequacy and reliability of controls.

2.8.3.1 Paint Shop Subsite Soil. The no-action alternative (Alternative 1) would not provide long-term effectiveness and permanence because contaminants would remain in soil. The institutional controls alternative (Alternative 2) would provide long-term effectiveness and permanence by imposing restrictions that would prevent future use of the site. Alternative 3 (off-site treatment and disposal) would provide long-term effectiveness and permanence by using treatment to reduce soil contaminant concentrations.

2.8.3.2 TNT Leaching Beds Subsite Soil. The no-action alternative (Alternative 1) would not provide long-term effectiveness and permanence because contaminants would remain in soil above health-based cleanup levels. The capping alternative (Alternative 2) would provide long-term effectiveness and permanence by imposing institutional controls that would prevent future use of the site and by preventing migration of soil contaminants. However, the long-term effectiveness and permanence may be limited if the integrity of the cap is not adequately maintained. Alternative 3 (composting) and Alternative 4 (off-site incineration and disposal) would provide long-term effectiveness and permanence by destroying soil contaminants. However, the transition point from short term to long term (i.e., the end of the remedial action implementation period) varies between Alternatives 3 and 4. Long term is considered to begin when cleanup levels are achieved: at least 1 year for Alternative 3, and approximately 3 months for Alternative 4.

2.8.3.3 TNT Leaching Beds Area Groundwater. The no-action alternative (Alternative 1) would not provide long-term effectiveness and permanence because contaminants would remain in groundwater without any institutional controls in place. It is anticipated that Alternative 2 will provide long-term effectiveness and permanence by using natural attenuation and degradation to reduce contaminant concentrations and institutional controls to prevent future use of groundwater. Groundwater would be monitored on a periodic basis to ensure that

contaminants are not migrating horizontally or vertically, and the site would be reviewed every 5 years by the Army and regulatory agencies. If Alternative 2 is not adequate, a contingency alternative (Alternative 4) as discussed in Section 2.7.3.2 will be implemented. Alternatives 3, 4, and 5 would provide long-term effectiveness and permanence by using active treatment to reduce groundwater contaminant concentrations.

2.8.3.4 Diesel Spill Area. The no-action alternative (Alternative 1) would not provide long-term effectiveness and permanence because diesel-related compounds would remain in soil and groundwater. Alternative 2 would provide long-term effectiveness and permanence by using bioventing to remediate soil and natural attenuation and degradation to prevent future groundwater use at the site. Groundwater would be monitored on a periodic basis to ensure that contaminants are not migrating horizontally or vertically, and the site would be reviewed every 5 years by the Army and regulatory agencies. Alternatives 3, 4, 5, and 6 would provide long-term effectiveness and permanence by using bioventing to biologically degrade soil and pump-and-treat and in situ methods to treat groundwater. However, the transition point from short term to long term (i.e., the end of the remedial action implementation period) varies between these alternatives. Long term is considered to begin when cleanup levels are achieved: at least 50 years for Alternatives 3 and 4, approximately 4 years for Alternative 5, and approximately 6 years for Alternative 6.

2.8.4 Reduction of Toxicity, Mobility, or Volume Through Treatment

Reduction of toxicity, mobility, or volume through treatment refers to the preference for a remedy that uses treatment to reduce health hazards, contaminant migration, or quantity of contaminants at the site.

2.8.4.1 Paint Shop Subsite Soil. Alternatives 1 and 2 would not reduce the toxicity, mobility, or volume of contaminants through treatment because these alternatives do not involve active treatment. Since Alternative 3 would involve treatment, the toxicity, mobility, and volume of soil contaminants would be reduced.

2.8.4.2 TNT Leaching Beds Subsite Soil. Alternatives 1 and 2 would not reduce the toxicity, mobility, or volume of contaminants through treatment because these alternatives do not involve active treatment. However, Alternative 2 (capping) would reduce the contaminant mobility by preventing surface water infiltration. Since Alternatives 3 and 4 would involve treatment, the toxicity, mobility, and volume of soil contaminants would be reduced.

2.8.4.3 TNT Leaching Beds Area Groundwater. Alternatives 1 and 2 would depend upon natural attenuation and degradation (not active treatment) to reduce the toxicity, mobility, or volume of contaminants. The pump-and-treat alternatives (Alternatives 3, 4, and 5) use active treatment to reduce the toxicity, mobility, or volume of groundwater contaminants.

2.8.4.4 Diesel Spill Area. Alternative 1 would not reduce the toxicity, mobility, or volume of contaminants through treatment because the alternative does not involve active treatment. Alternative 2 would use active treatment to reduce the toxicity, mobility, and volume

of contaminants in soil but would depend upon natural attenuation and degradation to reduce the toxicity, mobility, and volume of groundwater contaminants. Since Alternatives 3 through 6 involve active treatment, toxicity, mobility, and volume of soil and groundwater contaminants would be reduced at a higher rate.

2.8.5 Short-Term Effectiveness

Short-term effectiveness refers to the period of time needed to complete the remedy and any adverse impacts on human health and the environment that may be posed during the construction and implementation of the remedy.

2.8.5.1 Paint Shop Subsite Soil. All of the alternatives are judged to offer a high degree of short-term effectiveness because of the lack of risk posed to the community and/or workers during the construction and implementation phase. The off-site treatment and disposal alternative (Alternative 3) is the only alternative that could potentially expose the community/workers by excavating contaminated soil for off-site treatment and disposal. Alternative 3 could also provide exposure to contaminants during transportation of the soils to an off-site facility. However, any potential threat posed by soil excavation and transportation could be readily controlled by using appropriate dust control measures.

No adverse environmental impacts are anticipated from the construction and implementation of any of the alternatives.

2.8.5.2 TNT Leaching Beds Subsite Soil. All of the alternatives are judged to offer a high degree of short-term effectiveness because of the lack of risk posed to the community and/or workers during the construction and implementation phase. The composting alternative (Alternative 3) and off-site treatment and disposal alternative (Alternative 4) are the only alternatives that could potentially expose the community/workers by excavating contaminated soil for treatment. The community/workers could also be exposed during transportation of the soil to an off-site facility. However, any potential threat posed by soil excavation could be readily controlled by using appropriate dust control measures.

No adverse environmental impacts are anticipated from the construction and implementation of any of the alternatives.

2.8.5.3 TNT Leaching Beds Area Groundwater. All of the alternatives are judged to offer a high degree of short-term effectiveness because of the lack of risk posed to the community and/or workers during the construction and implementation phase. No adverse environmental impacts are anticipated from the construction and implementation of any of the alternatives.

2.8.5.4 Diesel Spill Area. All of the alternatives are judged to offer a high degree of short-term effectiveness because of the lack of risk posed to the community and/or workers during the construction and implementation phase. No adverse environmental impacts are anticipated from the construction and implementation of any of the alternatives.

2.8.6 Implementability

Implementability refers to the technical and administrative feasibility of a remedy, including availability of materials and services needed to implement the selected remedy. It also includes coordination of federal, state, and local governments in cleanup of the site.

2.8.6.1 Paint Shop Subsite Soil. Although all of the alternatives considered in the detailed analysis are readily implementable, Alternatives 1 and 2 offer the highest degree of implementability. For obvious reasons, Alternative 1 (no action) is easily implementable, requiring only soil monitoring. Alternative 2 (institutional controls) presents minimal implementability problems; however, institutional controls may be affected by future land use and may have to be modified to include deed restrictions or other site security measures. If this alternative was ultimately chosen for implementation, the possibility exists that at some time into the institutional action (if the Paint Shop Subsite were allowed public access), a change from continued Army security to deed restrictions and/or other site security would be necessary. Therefore, base closure would not preclude implementation of this alternative.

Alternative 3 (off-site treatment and disposal) should be easy to implement because it involves excavating a small volume of soil (approximately 110 cubic yards) and transporting it off site. The nearest treatment facility for the excavated soil is in Aragonite, Utah. However, it should be noted that the actual facility used for off-site treatment and disposal will be selected during the remedial design phase.

2.8.6.2 TNT Leaching Beds Subsite Soil. Although all of the alternatives considered in the detailed analysis are readily implementable, Alternatives 1 and 2 offer the highest degree of implementability. For obvious reasons, Alternative 1 (no action) is easily implementable. Alternative 2 (capping) presents minimal implementability problems; however, institutional controls may be affected by future land use and may have to be modified to include deed restrictions or other site security measures. The TNT Leaching Beds Area is currently under constant Army security with highly restricted access. If this alternative was ultimately chosen for implementation, the possibility exists that at some time into the institutional action (if the TNT Leaching Beds Subsite were allowed public access), a change from continued Army security to deed restrictions and/or other site security would be necessary. Therefore, base closure would not preclude implementation of this alternative.

Alternative 3 (composting) should be easy to implement because it involves excavating approximately 1,750 cy of soil and treating it on site. A treatability study will be performed prior to implementation of this alternative. The results of the treatability study would be used to implement the full-scale system. Alternative 4 (off-site incineration and disposal) may be more difficult to implement since this alternative would require transportation of the same volume of soil off site. The nearest facility for treatment and disposal is in Aragonite, Utah. However, it should be noted that the actual facility used for off-site treatment and disposal will be selected during the remedial design phase.

2.8.6.3 TNT Leaching Beds Area Groundwater. Although all of the alternatives considered in the detailed analysis are readily implementable, Alternatives 1 and 2 offer the highest degree of implementability. For obvious reasons, Alternative 1 (no action) is easily implementable, requiring only groundwater monitoring. Alternative 2 (natural attenuation and degradation) presents minimal implementability problems; however, institutional controls may be affected by future land use and may have to be modified to include deed restrictions or other site security measures. The TNT Leaching Beds Area is currently under constant Army security with highly restricted access. If SIAD were to undergo base closure and the public allowed access to the site, some modification to the types of institutional controls applied may be necessary. Due to the absence of natural contaminant exposure pathways, base closure would not preclude implementation of this alternative.

Groundwater remediation using pump-and-treat methods has been used at many sites; therefore, Alternatives 3, 4, and 5 should be relatively easy to implement.

2.8.6.4 Diesel Spill Area. As discussed for the other sites, the no-action and institutional controls alternatives 1 and 2 offer the highest degree of implementability. Because groundwater remediation using pump-and-treat methods has been used at many sites, Alternatives 3 and 4 should be relatively easy to implement. Alternatives 5 and 6 involve using innovative technologies for in situ groundwater treatment; therefore, these alternatives may be somewhat more difficult to implement due to less demonstrated experience. Treatability studies will be required to evaluate the effectiveness of Alternatives 5 and 6 for the Diesel Spill Area prior to full-scale implementation.

2.8.7 Cost

This criterion examines the estimated cost for each remedial alternative. For comparison, capital costs and annual operation and maintenance costs are used to calculate a present-worth cost for each alternative. A detailed cost analysis was performed for each of the alternatives proposed in the FS reports (JMM, 1992b; Montgomery Watson, 1993a; 1993b; 1994). For comparison purposes, a 30-year project period was used to evaluate the alternatives, unless the restoration timeframe was shorter. The actual project period will depend on the techniques employed coupled with periodic review and data analysis and conditions encountered during remediation.

The cost estimates for the alternatives have been developed for the purpose of comparing the alternatives. Specific cost elements are based on factors and a conceptual design and are not based on a detailed design. Consequently, the list of equipment may not be complete and the total estimated cost may not reflect actual costs incurred during the remediation project. Also, the estimated costs assume no changes in regulatory requirements and technologies affecting the remedial action.

The present-worth cost estimates of each alternative, assuming zero equipment salvage value, zero percent inflation, and a 7 percent discount rate, are shown for comparison in Figures 2-35 through 2-38.

2.8.7.1 Paint Shop Subsite Soil. Alternatives 1 and 2 are less costly and easier to implement than Alternative 3. However, these alternatives do not satisfy the two threshold criteria. Alternative 3 costs more to implement because this alternative involves excavation and off-site treatment/disposal.

2.8.7.2 TNT Leaching Beds Subsite Soil. Alternatives 1 and 2 are the least costly and the most implementable alternatives but they do not satisfy the two threshold criteria. Both Alternatives 3 and 4 satisfy the two threshold criteria but Alternative 4 would cost significantly more to implement than Alternative 3.

2.8.7.3 TNT Leaching Beds Area Groundwater. Alternatives 3, 4, and 5 cost significantly more than Alternatives 1 and 2 because these alternatives involve groundwater extraction and treatment. Despite its much lower cost, Alternative 2 (natural attenuation and degradation) satisfies the two threshold criteria.

2.8.7.4 Diesel Spill Area. Although Alternatives 1 and 2 have the lowest estimated costs, they do not satisfy the two threshold criteria. Alternatives 3, 4, 5, and 6 would satisfy the threshold criteria but Alternatives 3 and 4 would cost significantly more to implement than Alternatives 5 and 6. Although Alternative 6 (bioventing and vacuum vapor extraction) would cost more than Alternative 5 (bioventing and air sparging), the Army prefers vacuum vapor extraction because it is an innovative technology that could have applications at other sites if the performance of the technology can be demonstrated.

2.8.8 State/Support Agency Acceptance

State acceptance indicates whether, based on its review of the RI/FS and proposed plan, the state in which the site resides agrees with the preferred alternative. The Army, as the lead agency in preparing the ROD/RAP, has involved DTSC and RWQCB. The Army has responded to all state regulatory agency comments received during their reviews of the RI/FS reports and proposed plan. The state regulatory agencies support the selection of the preferred remedies discussed in Section 2.9.

2.8.8.1 Paint Shop Subsite Soil. The state regulatory agencies support the selection of Alternative 3 (off-site treatment and disposal) as the preferred remedy. The state regulatory agencies do not consider Alternatives 1 and 2 acceptable.

2.8.8.2 TNT Leaching Beds Subsite Soil. The state regulatory agencies support the selection of Alternative 3 (on-site composting) as the preferred remedy. The state regulatory agencies also consider Alternatives 2 and 4 acceptable but do not consider Alternative 1 acceptable.

2.8.8.3 TNT Leaching Beds Area Groundwater. The state regulatory agencies support the selection of Alternative 2 (natural attenuation and degradation) as the preferred remedy and Alternative 4 (groundwater extraction and treatment with air stripping and GAC adsorption) as

the contingency alternative. The state regulatory agencies also consider Alternatives 3 and 5 acceptable but do not consider Alternative 1 acceptable.

2.8.8.4 Diesel Spill Area. The state regulatory agencies support the selection of Alternative 6 (bioventing and vacuum vapor extraction) as the preferred remedy. The state regulatory agencies also consider Alternatives 3, 4, and 5 acceptable but consider Alternatives 1 and 2 acceptable.

2.8.9 Community Acceptance

Community acceptance indicates the public support of a given alternative. Section 3.0 of this ROD/RAP documents the community acceptance of the selected remedies, as presented in the proposed plan. Section 3.0 includes a responsiveness summary that addresses the oral comments received during the public comment period. No written comments were received during the public comment period. The community did not express any significant objections to the selected remedies during the public meeting or public comment period.

2.9 SELECTED REMEDIES

The selection of the various remedies is based on the comparative analysis of the alternatives presented in Section 2.8 and provides the best of trade-offs with respect to the nine evaluation criteria. The following subsections describe the conceptual engineering and operation and maintenance features of the selected remedies. The current conceptual design parameters are listed for indication purposes. The specific details will be determined during the remedial design phase and, therefore may be different than those listed and discussed. Such differences will not require a modification of this ROD/RAP, unless they result in a substantial modification of a selected remedy.

2.9.1 Paint Shop Subsite Soil

The Army has selected Alternative 3 (off-site treatment and disposal) as the remedy for the contaminated soil at the Paint Shop Subsite. Although human health risks are within acceptable ranges, the Army has determined that remediation of the contaminated soil is beneficial to the overall protection of human health and the environment. Based on information obtained during the RI and on a careful analysis of all remedial alternatives, the State of California concurs with the selected remedy.

2.9.1.1 Description. Alternative 3 would involve excavating approximately 110 cy (140 tons) of soil and transporting it to an off-site facility for treatment and disposal. It is assumed that incineration will be used to treat the soil. Incineration is a proven technology in remediating soils contaminated with VOCs and SVOCs. The nearest off-site treatment and disposal facility is in Aragonite, Utah. It should be noted, however, that the actual facility used for off-site treatment and disposal will be selected during the remedial design phase.

2.9.1.2 Estimated Costs. Costs for the off-site treatment and disposal alternative include costs for soil excavation, transportation, and off-site treatment and disposal. The total present-worth cost for this alternative is $480,000. Costs for Alternative 3 are summarized in Table 2-34.

2.9.2 TNT Leaching Beds Subsite Soil

The Army has selected Alternative 3 (excavation and on-site composting) as the remedy for the contaminated soil at the TNT Leaching Beds Subsite. Based on information obtained during the RI and on a careful analysis of all remedial alternatives, the State of California concurs with the selected remedy.

2.9.2.1 Description. This alternative consists of excavating approximately 1,750 cubic yards (2,300 tons) of soil and treating it using composting. The soil would be excavated using conventional excavation equipment. Composting is a controlled biological process by which biodegradable materials are converted by microorganisms to innocuous, stabilized byproducts. In most cases, this is achieved by the use of indigenous microorganisms.

Contaminated soils would be mixed with bulking agents such as wood chips, and organic amendments such as animal, fruit, and vegetable wastes. It is assumed that windrow composting would be used. Composting would result in approximately a twofold volumetric increase in material due to the addition of amendment material. A temporary structure would be used to prevent potential wind dispersal of explosives-contaminated dusts, and a lined pad would be constructed to prevent possible leaching of explosives into the ground.

Based on the results of bench- and pilot-scale composting studies performed at other Army facilities, it is anticipated that the time required to complete the composting remedial action is approximately 1 year. Soil samples would be collected and analyzed on a periodic basis to monitor the effectiveness of treatment. Once treatment is complete, it is assumed that approximately half of the compost material would be backfilled. Any excess compost material that cannot be backfilled will be disposed offsite at an appropriately licensed disposal facility. A treatability study would be required prior to full-scale implementation of composting at the TNT Leaching Beds Subsite.

2.9.2.2 Estimated Costs. Costs for the composting alternative include costs for site preparation, excavation, backfilling, and capital and operating costs for the composting treatment system. The total present-worth cost for this alternative is $1.4 million. Costs for Alternative 3 are summarized in Table 2-35.

2.9.3 TNT Leaching Beds Area Groundwater

The Army has selected Alternative 2 (natural attenuation and degradation) as the remedy for the contaminated groundwater at the TNT Leaching Beds Area. Based on information obtained

TABLE 2-34

COST ANALYSIS FOR ALTERNATIVE 3
OFF-SITE INCINERATION AND DISPOSAL
PAINT SHOP SUBSITE SOIL

Item/Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
DIRECT CAPITAL COSTS (DCC)				
Field Costs				
Soil Excavation	110	cubic yard	$10	$1,100
Loading/Transportation	140	ton	$125	$17,500
Soil Treatment and Disposal	140	ton	$2,000	$280,000
State Taxes	140	ton	$35	$4,900
Backfill with Clean Soil	110	cubic yard	$11	$1,210
			Subtotal DCC	$300,000
Contingency		20% of DCC		$60,000
Contractor's Overhead and Profit		20% of DCC		$60,000
INDIRECT CAPITAL COSTS				
Non-Design Engineering		4% of DCC		$12,000
Administration Costs (SIAD/USACE)		17% of DCC		$51,000
	TOTAL CAPITAL REQUIREMENT			$480,000
ANNUAL OPERATING AND MAINTENANCE COSTS				
None				
PRESENT WORTH				
		Discount Rate	7%	
		Years	1	
	TOTAL PRESENT WORTH			$480,000

TABLE 2-35

COST ANALYSIS FOR ALTERNATIVE 3
EXCAVATION AND ON-SITE COMPOSTING
TNT LEACHING BEDS SUBSITE SOIL
(Page 1 of 2)

Item/Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
DIRECT CAPITAL COSTS (DCC)				
Soil Excavation	1,750	cubic yard	$10	$17,500
Composting				
Site Clearing	4	acre	$5,000	$20,000
Asphalt Pad	18,000	square foot	$8	$144,000
Temporary Structure Rental	12,000	square foot	$4.50	$54,000
Haul Truck Rental	12	month	$1,600	$19,200
Front-End Loader Rental	12	month	$1,650	$19,800
Windrow Turner Rental	12	month	$7,000	$84,000
Pickup Truck Rental	12	month	$500	$6,000
Backfill with Compost Material	1,750	cubic yard	$11	$19,250
Disposal of Compost Material	1,750 (a)	cubic yard	$20	$35,000
			Subtotal DCC	$418,750
Contingency		20% of DCC		$83,750
Contractor's Overhead and Profit		20% of DCC		$83,750
INDIRECT CAPITAL COSTS				
Engineering Design		10% of DCC		$41,875
Non-Design Engineering		4% of DCC		$16,750
Administration Costs (SIAD/USACE)		17% of DCC		$71,188
Office Engineering During Construction		5% of DCC		$20,938
Construction Management		9% of DCC		$37,688
Final O&M Manuals		2% of DCC		$8,375
	TOTAL CAPITAL REQUIREMENT			$780,000
ANNUAL OPERATING AND MAINTENANCE COSTS				
Composting				
Amendments	5,250	cubic yard	$50	$262,500
Labor (Supervisor)	1	man-year	$49,920	$49,920
Labor (Laborer)	2	man-year	$33,280	$66,560
Sampling and Analysis	2,300	ton	$33	$75,900
Permitting	2,300	ton	$17	$39,100
USACE Support	2,300	ton	$12	$28,290
Miscellaneous O&M	2,300	ton	$34	$78,200
			Composting Subtotal	$600,000

(a) It is assumed that material volume will increase twofold.

TABLE 2-35

COST ANALYSIS FOR ALTERNATIVE 3
EXCAVATION AND ON-SITE COMPOSTING
TNT LEACHING BEDS SUBSITE SOIL
(Page 2 of 2)

Item/Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
PRESENT WORTH				
		Discount Rate	7%	
		Years	1	
	TOTAL PRESENT WORTH			$1,400,000

during the RI and on a careful analysis of all remedial alternatives, the State of California concurs with the selected remedy.

The site-specific hydrogeologic and land use conditions at the site are highly favorable for use of the natural attenuation and degradation alternative.

The contaminant plume beneath the TNT Leaching Beds Area consists of relatively low concentrations of chemicals in groundwater and is stable. Due to the hydrogeology of the aquifer, movement of groundwater contaminants occurs at a slow rate. The horizontal extent of the plume has been characterized through the installation and sampling of 16 monitoring wells and collection of three additional groundwater samples by drive sampling. Further characterization of the horizontal and vertical extent of the plume will be performed as part of the selected remedy. An extensive groundwater monitoring program included in the selected remedy will provide substantial data on changes in chemical concentrations and aquifer conditions. Monitoring of these changes over time will provide a basis for prediction of future plume concentrations and migration. Implementation of the selected remedies for soil cleanup will remove potential sources of groundwater contamination and will prevent further degradation of water quality.

The TNT Leaching Beds Area is a restricted access area of Sierra Army Depot protected by locked or guarded gates. The nearest water supply wells are approximately 1.5 miles south (upgradient) of the site. Institutional controls will prevent use of groundwater in the surrounding areas and prevent possible exposure. The area surrounding the TNT Leaching Beds Area is used for longer term storage of ammunition. Future land use is not expected to change and is conducive to use of natural attenuation and degradation to restore water quality.

2.9.3.1 Description. This alternative evaluates the restoration of groundwater by an evaluation of attenuation and degradation processes that naturally occur within the aquifer. The alternative consists of:

- Further characterization of site hydrogeology
- Evaluation of natural attenuation degradation and contaminant migration rates
- Institutional controls to minimize exposure to groundwater contaminants at the site
- Groundwater monitoring to measure contaminant degradation and migration rates

The proposed program of further hydrogeologic characterization will include drilling, logging, and sampling of six deep soil borings to provide more detailed data on the hydrogeology of the site. Additional groundwater monitoring wells will be installed and additional groundwater samples will be collected by drive sampling at various depths and locations throughout the TNT Leaching Beds Area. The number of borings, monitoring wells, and groundwater samples will depend upon the types of sediments and extent of groundwater contamination encountered. Flowcharts showing the decision trees for installing the additional wells are presented in the Army's October 22, 1993 letter to the State of California. The proposed program may include up to 15 deep soil borings, 36 monitoring wells, and 15 groundwater samples collected by drive samplers. The exact number of soil borings, groundwater monitoring wells, and groundwater

samples will be determined in the RD/RA Phase and will not require a modification of this ROD/RAP if different from this proposal. Furthermore, additional soil borings and/or groundwater monitoring wells may be deemed necessary during the 5-year study and will be negotiated through the FFSRA. During the first year of groundwater monitoring, monitoring data will be collected on a quarterly basis and elevation data will be collected on a monthly basis. From the first to fifth year, groundwater monitoring data will be collected on an annual basis, if deemed appropriate. An initial list of monitoring parameters and the rationale for monitoring those parameters is provided in Table 2-27. Groundwater modeling may also be conducted, if warranted. Specific details of the groundwater monitoring and evaluation program will be established in the RD/RA Phase and may be modified through the FFSRA without revision of this ROD/RAP. The Army will submit status reports on the results of groundwater monitoring to the State of California based on the following schedule:

- no later than 18 months after the effective (last signature) date of the ROD/RAP
- no later than 36 months after the effective date of the ROD/RAP
- no later than 5 years after the effective date of the ROD/RAP

During or following completion of the 5-year groundwater monitoring program, the Army and State of California will review all hydrogeologic and chemical data to determine whether further implementation of the natural attenuation and degradation alternative is appropriate. If the extent of horizontal and vertical contaminant migration and apparent rates of contaminant migration and degradation are not acceptable to either the Army or State of California, Alternative 2 will not be further implemented and a contingency alternative will be implemented. The contingency alternative consists of Alternative 4 (Groundwater Extraction and Treatment with Air Stripping and GAC Adsorption) discussed in Section 2.7.3.4. In the event that the contingency alternative is implemented, the Army will work with the State of California who will develop substantive waste discharge requirements for the disposal of treated groundwater. Those substantive waste discharge requirements will specify the appropriate effluent discharge standards, monitoring programs, and other relevant performance criteria.

However, the Army may propose a new contingency alternative that is superior to Alternative 4 prior to the end of the 5-year study period. Upon agreement by the Army and State of California, the new contingency alternative will be evaluated and implemented. The schedule for selection and implementation of the new contingency alternative will follow the procedures specified in Section 8 (Deadlines) of the SIAD Federal Facility Site Remediation Agreement (FFSRA). The Army will continue to periodically review the feasibility of natural attenuation and degradation and other potential remedial technologies. If any action taken during the 5-year period leads to a dispute, such dispute will be resolved via Section 12 (Dispute Resolution) of the SIAD FFSRA.

If, during the 5-year groundwater monitoring program, the extent of horizontal and vertical contaminant migration and apparent rates of contaminant migration and degradation are acceptable to the Army and State of California, long-term groundwater monitoring and institutional controls will be implemented. The frequency of subsequent groundwater monitoring will be determined following a review of site data conducted 5 years after the implementation

of Alternative 2. Future site review activities will be conducted every 5 years pursuant to CERCLA §121(c) to assure that contaminant migration and degradation rates are within ranges that are acceptable to the Army and State of California. Institutional controls would restrict the use of groundwater at the site during the long-term groundwater monitoring.

2.9.3.2 Estimated Costs. Costs for the natural attenuation and degradation alternative include costs for site preparation and capital and operating costs for the groundwater monitoring system. The total present-worth cost for this alternative is $1.9 million. Costs for Alternative 2 are summarized in Table 2-36.

2.9.4 Diesel Spill Area

The Army has selected Alternative 6 (in situ bioventing and vacuum vapor extraction) as the remedy for the contaminated soil and groundwater at the Diesel Spill Area site. Site remediation will be achieved when the TPH concentrations in soil have been reduced to the state-recommended cleanup level of 100 mg/kg and TPH concentrations in groundwater have been reduced to the remediation level of 100 μg/l. As discussed in Section 2.8.2.4, cleanup levels for the Diesel Spill Area have been set to comply with SWRCB Resolution No. 92-49. Based on information obtained during the RI and on a careful analysis of all remedial alternatives, the State of California concurs with the selected remedy.

2.9.4.1 Description. This alternative utilizes bioventing to remediate soil, and vacuum vapor extraction to remediate groundwater. Bioventing uses forced aeration to enhance the natural biodegradation of organic compounds in soil. Soil aeration would be achieved using two air injection vents within the area of soil contamination (Figure 2-39). The two air injection vents would be screened between 10 and 40 feet below ground surface to provide forced aeration within the zone of soil contamination surrounding the vents. Because soil contamination below a depth of 40 feet is limited to the immediate vicinity of the planned vacuum vapor extraction well, the soil aeration provided by the vacuum vapor extraction well will be sufficient to biovent the deeper soils. This alternative is estimated to take approximately 4 years to reduce TPH concentrations in soil to below the 100 mg/kg cleanup level. To assess the feasibility of bioventing, a treatability study would be performed prior to implementation of this alternative. The treatability study would quantify in situ soil-gas permeability, radius of influence of the air injection vents, and potential biodegradation rates. The results of the treatability study would be used to implement the full-scale system.

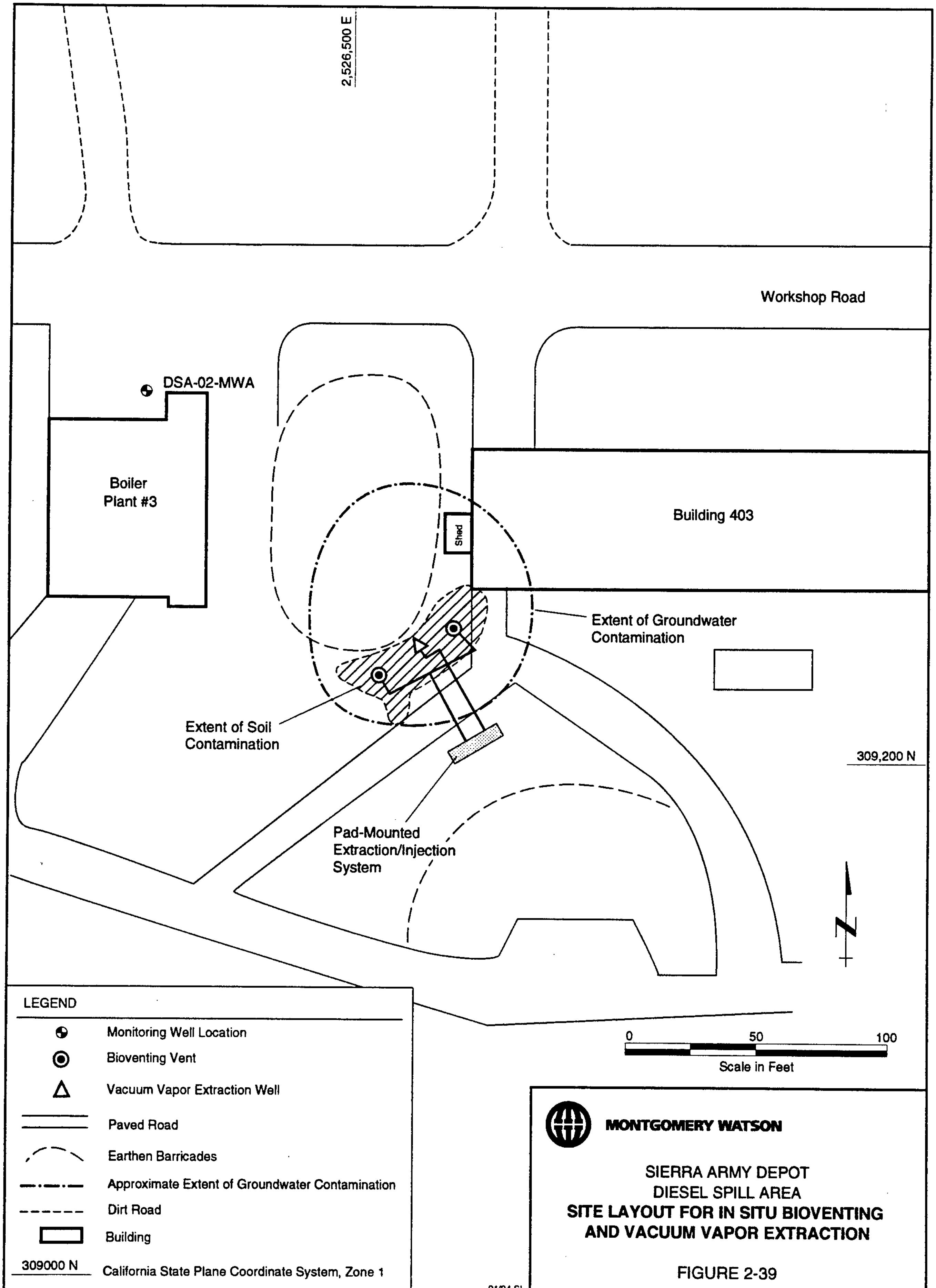
The vacuum vapor extraction technology uses specially designed wells with upper and lower screen zones to create a vertical circulation pattern in the aquifer. A constant negative air pressure is created within the well casing using a blower. As a result, ambient air is drawn through a pipe at the surface and enters the well through a reactor that strips air. Movement of the air bubbles through the water column oxygenates the groundwater. A separating plate and pump controls the groundwater flow from the lower to upper screen sections. Due to oxygen enrichment of the groundwater leaving the well, biological degradation in the aquifer is enhanced. Because the air is being drawn into the top screen, vacuum vapor extraction wells can also "biovent" soils above the water table. It is assumed that one 8-inch vacuum vapor

TABLE 2-36

COST ANALYSIS FOR ALTERNATIVE 2
NATURAL ATTENUATION AND DEGRADATION
TNT LEACHING BEDS AREA GROUNDWATER

Item/Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
DIRECT CAPITAL COSTS (DCC)				
Installation of Additional Monitoring Equipment		lump sum	$650,000	$650,000
Groundwater Monitoring				
Preparation of Monitoring Plan	1	each	$10,000	$10,000
Deed Restrictions (e)		lump sum		$50,000
			Subtotal DCC	$710,000
Contingency		20% of DCC		$142,000
Contractor's Overhead and Profit		20% of DCC		$142,000
INDIRECT CAPITAL COSTS				
Administration Costs (SIAD/USACE)		17% of DCC		$120,700
TOTAL CAPITAL REQUIREMENT				$1,115,000
ANNUAL OPERATING AND MAINTENANCE COSTS				
Groundwater Monitoring (years 0-1) (a)	4	event	$59,000	$236,000
Groundwater Monitoring (years 1-5) (b)	1	event	$41,000	$41,000
Groundwater Monitoring (years 6-30) (b)	1	event	$41,000	$41,000
18-month Site Review		event		$10,000
36-month Site Review		event		$10,000
5-Year Site Review		event		$10,000
PRESENT WORTH				
		Discount Rate	7%	
		Years	30	
TOTAL PRESENT WORTH				$1,900,000

ASSUMPTIONS
(a) Monitoring costs are for 24 wells
(b) Monitoring costs are for 16 wells
(c) Lab analysis includes VOCs (GC/MS), explosives, and priority pollutant metals.
(d) Rehabilitation of the monitoring wells will be necessary after 15 years (Costs not included)
(e) The estimated cost for deed restrictions has a high degree of uncertainty.



SIERRA ARMY DEPOT
DIESEL SPILL AREA
SITE LAYOUT FOR IN SITU BIOVENTING AND VACUUM VAPOR EXTRACTION

FIGURE 2-39

extraction well installed at the center of the diesel plume will be sufficient to treat the groundwater. To monitor performance, two 2-inch monitoring wells would be installed in the same borehole as the vacuum vapor extraction well. These two monitoring wells would be used to monitor groundwater at the top and bottom screens of the vacuum vapor extraction well. Extracted air from the vacuum vapor extraction well would be treated with GAC to remove any VOCs present in the air stream. This alternative is estimated to take approximately 6 years to restore groundwater.

2.9.4.2 Estimated Costs. Costs for the bioventing and vacuum vapor extraction alternative include costs for site preparation and capital and operating costs for the bioventing/vacuum vapor extraction treatment system. The total present-worth cost for this alternative is $1.0 million. Costs for Alternative 6 are summarized in Table 2-37.

2.10 STATUTORY DETERMINATIONS

2.10.1 Paint Shop Subsite Soil

The selected remedy satisfies the statutory requirements of CERCLA §121 and CERCLA §120(a)(4), as amended by SARA, in that the following mandates are attained:

- The selected remedy is protective of human health and the environment.
- The selected remedy complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action.
- The selected remedy is cost effective.
- The selected remedy utilizes permanent solutions and alternative treatment technologies or resource recovery technologies, to the maximum extent practicable.
- The selected remedy satisfies the preference for treatment that reduces toxicity, mobility, and/or volume as a principal element.

The following sections describe how the selected remedy satisfies each of the statutory requirements described above.

2.10.1.1 Protection of Human Health and the Environment. The baseline risk assessment determined that potential cancer and noncancer risks are acceptable according to current USEPA guidelines ($<10^{-4}$ risk level) for current and future exposure scenarios. Potential cancer risks to future construction workers are considered acceptable according to current USEPA and DTSC guidelines but are slightly above the 10^{-6} risk level. As discussed in Section 2.6.1.4, the magnitude of acceptable cancer risk relative to Superfund site remediation goals in the NCP generally ranges from 10^{-4} to 10^{-6} (one in one million) depending on the site,

TABLE 2-37

COST ANALYSIS FOR ALTERNATIVE 6
IN SITU BIOVENTING AND VACUUM VAPOR EXTRACTION
DIESEL SPILL AREA
(Page 1 of 2)

Item/Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
DIRECT CAPITAL COSTS (DCC)				
Equipment Costs (EC)				
Collection Piping (3-inch PVC)	300	linear foot	$20	$6,000
GAC Vapor Control unit	1	each	$2,000	$2,000
Bioventing Blower	1	each	$5,000	$5,000
Vacuum Vapor Extraction System	1	each	$50,000	$50,000
			Subtotal EC	$63,000
Field Costs				
Surface Repair/Preparation		lump sum		$3,000
Bioventing Vents, VVE Borehole, Monitoring Wells		lump sum		$69,000
Contaminated Soil Disposal	10	cubic yard	$200	$2,000
Equipment Pad		lump sum	$2,500	$2,500
Permitting		lump sum	$10,000	$10,000
Mechanical		40% of EC		$25,200
Instrumentation		10% of EC		$6,300
Electrical		20% of EC		$12,600
			Subtotal DCC	$193,600
Contingency		20% of DCC		$38,720
Contractors Overhead and Profit		20% of DCC		$38,720
INDIRECT CAPITAL COSTS				
Treatability Study		lump sum	$25,000	$25,000
Engineering Design		10% of DCC		$19,360
Administration Costs (SIAD/USACE)		17% of DCC		$32,912
Office Engineering During Construction		5% of DCC		$9,680
Construction Management		9% of DCC		$17,424
Final O&M Manuals		2% of DCC		$3,872
		TOTAL CAPITAL REQUIREMENT		$301,000

TABLE 2-37

COST ANALYSIS FOR ALTERNATIVE 6
IN SITU BIOVENTING AND VACUUM VAPOR EXTRACTION
DIESEL SPILL AREA
(Page 2 of 2)

Item/Description	Quantity	Unit	Unit Cost ($)	Total Cost ($)
ANNUAL OPERATING AND MAINTENANCE COSTS				
Bioventing/Vacuum Vapor Extraction System (Years 1 - 6)				
Energy	55,000	kw-hr	$0.10	$5,500
Labor	1	man-year	$75,000	$75,000
Effluent Air Monitoring	12	each	$225	$2,700
Maintenance Materials		5% of EC		$3,150
GAC Replacement	500	lbs	$4.50	$2,250
Groundwater Monitoring		lump sum	$24,000	$24,000
Soil Monitoring		lump sum	$23,000	$23,000
			Subtotal	$135,600
5-Year Site Review		event		$5,000
Demobilization (Year 6)				
System Demolition		lump sum		$20,000
Vent/Well Abandonment	6	each	3,000	$18,000
Site Closure Analyses		lump sum	$45,000	$45,000
			Subtotal	$83,000
PRESENT WORTH				
		Discount Rate	7%	
		Years	6	
	TOTAL PRESENT WORTH			$1,000,000

ASSUMPTIONS
(a) Effluent air monitoring is performed on a monthly basis.
(b) Groundwater monitoring will be performed on a semi-annual basis.
(c) Groundwater monitoring costs are for 3 monitoring wells and 2 VVE monitoring wells.
(d) Lab analysis for groundwater monitoring includes VOCs (GC/MS) and TPH-diesel.
(e) Vacuum vapor extraction system includes 5-HP blower, blower enclosure with moisture knockout, in situ stripping reactor, support pump, packers, screen sections, and all connections for installation within 5 ft. of wellhead.

proposed usage, and chemicals of concern (USEPA, 1991c). Within this range, the level of risk that is considered to be acceptable at a specific site is decided on a case-specific basis. The one-in-one-million level of risk (expressed as 10^{-6}) is often referred to as the *de minimus* level of risk. However, DTSC has not endorsed 10^{-6} as a universally acceptable level of risk.

The baseline risk assessment also concluded that contaminated soils at this subsite pose minimal risks to ecological receptors. Although human health and ecological risks are within acceptable ranges, the Army has determined that remediation of the contaminated soil is beneficial to the overall protection of human health and the environment. As discussed in Section 2.8.1.1, health-based remediation levels (Table 2-28) have been calculated. Alternative 3, the selected remedy would significantly reduce contaminant concentrations at the site.

Section 2.8.5 discussed the short-term effectiveness of the evaluated alternatives. The selected remedy will not pose unacceptable short-term risks to human health or to environment during implementation.

2.10.1.2 Compliance with Applicable or Relevant and Appropriate Requirements. The selected remedy of excavation and off-site treatment/disposal will comply with all applicable or relevant and appropriate chemical-, action-, and location-specific ARARs. The ARARs are presented below.

Chemical-Specific ARARs. None.

Location-Specific ARARs. None.

Action-Specific ARARs.

California requirements for discharges of waste to land in 23 CCR, Div. 3, Chapter 15, §2500 et seq.

California requirements for hazardous waste management in 22 CCR, Div. 4, Chapter 30, §66001 et seq.

California and federal requirements for occupational health and safety in Labor Code, Div. 5, §6300 et seq., and 29 USC §§651-678, respectively.

Regional Water Quality Objectives in the Water Quality Control Plan ("Basin Plan") for the Lahontan RWQCB.

Requirements for investigation, cleanup, and abatement of discharges in SWRCB Resolution No. 92-49.

Other Criteria, Advisories, or Guidance To Be Considered for this Remedial Action (TBCs). The health-based cleanup levels developed for the Paint Shop Subsite are TBCs.

2.10.1.3 Cost Effectiveness. The selected remedy, Alternative 3, utilizes cost effective treatment for the type and volume of contaminants present. Although Alternative 3 will cost more than the no-action and institutional controls alternatives, this alternative will satisfy the regulatory preference for active treatment, when practicable (40 CFR 300.430 (a)(1)(iii)(A)).

2.10.1.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable. Figure 2-35 summarizes the detailed analysis of the alternatives with respect to the CERCLA-mandated evaluation criteria and identifies the major trade-offs of the selected remedy. The selected remedy, Alternative 3, by actively treating the soil, satisfies the statutory preference to utilize permanent solutions and treatment technologies to the maximum extent practicable.

2.10.1.5 Preference for Treatment as a Principal Element. The selected remedy employs active treatment of the soil to reduce soil contaminant concentrations. Therefore, the CERCLA preference for treatment is satisfied by the selected remedy.

2.10.2 TNT Leaching Beds Subsite Soil

The selected remedy satisfies the statutory requirements of CERCLA §121 and CERCLA §120(a)(4), as amended by SARA, in that the following mandates are attained:

- The selected remedy is protective of human health and the environment.
- The selected remedy complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action.
- The selected remedy is cost effective.
- The selected remedy utilizes permanent solutions and alternative treatment technologies or resource recovery technologies, to the maximum extent practicable.
- The selected remedy satisfies the preference for treatment that reduces toxicity, mobility, and/or volume as a principal element.

The following sections describe how the selected remedy satisfies each of the statutory requirements described above.

2.10.2.1 Protection of Human Health and the Environment. The baseline risk assessment determined that noncancer risks to future construction workers are unacceptable according to current USEPA and DTSC guidelines. The primary compounds contributing to these risks are 2,4,6-TNT and RDX. The baseline risk assessment also concluded that the contaminated soils at this subsite pose minimal risks to ecological receptors.

Therefore, the objective for remediating soils is to reduce soil contaminant concentrations to below levels resulting in an aggregate cancer risk of less than 10^{-6} and noncancer hazard index of less than 1.0. As discussed in Section 2.8.1.2, health-based remediation levels (Table 2-29) have been calculated. Alternative 3, the selected remedy would significantly reduce contaminant concentrations at the site.

Section 2.8.5 discussed the short-term effectiveness of the evaluated alternatives. The selected remedy will not pose unacceptable short-term risks to human health or the environment during implementation.

2.10.2.2 Compliance with Applicable or Relevant and Appropriate Requirements. The selected remedy of composting will comply with all applicable or relevant and appropriate chemical-, action-, and location-specific ARARs. The ARARs are presented below.

Chemical-Specific ARARs. None.

Location-Specific ARARs. None.

Action-Specific ARARs.

California requirements for discharges of waste to land in 23 CCR, Div. 3, Chapter 15, §2500 et seq.

California requirements for hazardous waste management in 22 CCR, Div. 4, Chapter 30, §66001 et seq.

California and federal requirements for occupational health and safety in Labor Code, Div. 5, §6300 et seq., and 29 USC §§651-678, respectively.

Regional Water Quality Objectives in the Water Quality Control Plan ("Basin Plan") for the Lahontan RWQCB.

Requirements for investigation, cleanup, and abatement of discharges in SWRCB Resolution No. 92-49.

Other Criteria, Advisories, or Guidance To Be Considered for this Remedial Action (TBCs). The health-based cleanup levels that have been calculated for soils are TBCs.

2.10.2.3 Cost Effectiveness. As discussed previously, Alternative 3 (excavation and on-site composting) is effective; and will eventually achieve the health-based remediation levels. In addition, Alternative 3 satisfies the regulatory preference for active treatment, when practicable (see 40 CFR 300.430 (a)(1)(iii)(A)). The selected remedy (Alternative 3) is cost effective.

2.10.2.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable. Figure 2-36 summarizes the detailed analysis of the alternatives with respect to the CERCLA-mandated evaluation criteria and identifies the major trade-offs of the selected remedy. The selected remedy, Alternative 3, by actively treating the soil, satisfies the statutory preference to utilize permanent solutions and treatment technologies to the maximum extent practicable.

2.10.2.5 Preference for Treatment as a Principal Element. The selected remedy employs active treatment of the soil to reduce soil contaminant concentrations below health-based cleanup levels. Therefore, the CERCLA preference for treatment is satisfied by the selected remedy.

2.10.3 TNT Leaching Beds Area Groundwater

The selected remedy and contingency alternative satisfy the statutory requirements of CERCLA §121 and CERCLA §120(a)(4), as amended by SARA, in that the following mandates are attained:

- The selected remedy and contingency alternative are protective of human health and the environment.
- The selected remedy and contingency alternative comply with federal and state requirements that are applicable or relevant and appropriate to the remedial action.
- The selected remedy and contingency alternative are cost effective.
- The selected remedy and contingency alternative utilize permanent solutions and alternative treatment technologies or resource recovery technologies, to the maximum extent practicable.
- The selected remedy and contingency alternative satisfy the preference for treatment that reduces toxicity, mobility, and/or volume as a principal element.

The following sections describe how the selected remedy satisfies each of the statutory requirements described above.

2.10.3.1 Protection of Human Health and the Environment. The baseline risk assessment determined that potential cancer risks and noncancer health effects to future residents are unacceptable according to current USEPA and DTSC guidelines. Compounds contributing to these risks are arsenic; TCE; carbon tetrachloride; chloroform; 1,2-DCA; 2,4-DNT; RDX; and 2,4,6-TNT. As discussed previously, arsenic was detected at levels below background and state and federal MCLs.

As discussed in Section 2.8.1.3, SWRCB Resolution No. 92-49 requires that groundwater must be remediated in a manner that promotes attainment of background water quality or the best water quality that is reasonable if background concentrations cannot be achieved. The future use of the groundwater at this site is highly unlikely given the planned long-term land use of the site. The planned long-term future use of the site is ammunition renovation and storage which will prohibit residential and agricultural development. Therefore, the remedial objectives for TNT Leaching Beds Area groundwater are to allow natural attenuation and degradation to prevent further groundwater contamination, and provide a long-term reduction in contaminant levels to attempt to restore background concentrations to protect human health and the environment. Alternative 2, the selected remedy would involve further characterization of the hydrogeology of the site, evaluation of natural attenuation/degradation and contaminant migration rates, installation of additional groundwater monitoring points, and institutional controls to prevent use of groundwater at the site. A groundwater monitoring network would be used to evaluate compliance. If the rate of natural attenuation and degradation is not acceptable, the contingency alternative (Alternative 4) will be implemented.

Section 2.8.5 discussed the short-term effectiveness of the evaluated alternatives. The selected remedy and contingency alternative will not pose unacceptable short-term risks to human health or the environment during implementation.

2.10.3.2 Compliance with Applicable or Relevant and Appropriate Requirements. The selected remedy and contingency alternative will comply with all applicable or relevant and appropriate chemical-, action-, and location-specific ARARs. The ARARs are presented below.

Chemical-Specific ARARs. As discussed in Section 2.8.1.3, water quality objectives presented in the Basin Plan have been used to develop the protective water quality objectives presented in Table 2-30. Of the compounds of concern in groundwater at the TNT Leaching Beds Area, there are state and federal MCLs for TCE, carbon tetrachloride, and 1,2-dichloroethane but there are no MCLs for any of the explosives compounds or chloroform. There are no SMCLs for any of the COCs. For those compounds that do have MCLs or SMCLs (i.e., explosives and chloroform), the protective water quality objectives are based on water quality guidance levels published in "A Compilation of Water Quality Goals" (Central Valley RWQCB, 1993). These guidance levels are TBCs. The selected remedy would depend upon natural attenuation and degradation acting over a long period of time to reduce groundwater contaminant concentrations. The contingency alternative would use groundwater extraction and treatment to reduce contaminant concentrations.

Location-Specific ARARs. None.

Action-Specific ARARs.

California requirements for discharges of waste to land in 23 CCR, Div. 3, Chapter 15, §2500 et seq.

California requirements for hazardous waste management in 22 CCR, Div. 4, Chapter 30, §66001 et seq.

California and federal requirements for occupational health and safety in Labor Code, Div. 5, §6300 et seq., and 29 USC §§651-678, respectively.

Selected provisions of the Porter-Cologne Water Quality Act (California Water Code).

Regional Water Quality Objectives in the Water Quality Control Plan ("Basin Plan") for the Lahontan RWQCB.

Requirements for investigation, cleanup, and abatement of discharges in SWRCB Resolution No. 92-49. Application of this ARAR is discussed in Section 2.8.1.3.

Other Criteria, Advisories, or Guidance To Be Considered for this Remedial Action (TBCs). The groundwater remediation levels based on non-promulgated health-based guidance levels are TBCs.

2.10.3.3 Cost Effectiveness. The selected remedy (natural attenuation and degradation) is the most cost effective alternative to provide overall protection of human health and the environment. The pump-and-treat alternatives (Alternatives 3, 4, and 5) would satisfy the preference for active treatment; however, these alternatives may not be practicable because full restoration of the groundwater in a reasonable amount of time is not expected. Because future groundwater use at the site is very unlikely, the high costs for the pump-and-treat alternatives to potentially achieve cleanup within a shorter time period do not seem warranted. Therefore, the selected remedy is a more cost effective means of providing protection to human health and the environment.

2.10.3.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable. Figure 2-36 summarizes the detailed analysis of the alternatives with respect to the CERCLA-mandated evaluation criteria and identifies the major trade-offs of the selected remedy. The selected remedy, Alternative 2, meets the statutory requirement to utilize permanent solutions and treatment technologies to the maximum extent practicable. Although Alternative 2, natural attenuation and degradation, does not employ active treatment, it is believed that the intrinsic remediation processes of this alternative will result in a permanent solution. Further, if the natural attenuation and degradation alternative is deemed unacceptable, the contingency alternative, pump and treat, will utilize permanent solutions and treatment technologies. The selected remedy is more implementable than the pump-and-treat alternatives. The pump-and-treat alternatives provide greater short-term effectiveness and reduction of TMV through treatment than the selected remedy. Due to the long time periods required for all alternatives and the potential limited performance of the pump-and-treat alternatives, the long-term effectiveness and permanence of the pump-and-treat alternatives is slightly but not significantly better than the selected remedy. The greater short-term effectiveness, greater reduction of TMV, and slightly better long-term

effectiveness of the pump-and-treat alternatives are offset by the cost effectiveness of the selected remedy.

2.10.3.5 Preference for Treatment as a Principal Element. The selected remedy does not employ active treatment of the groundwater. However, natural processes will result in degradation of contaminants to less toxic compounds.

2.10.4 Diesel Spill Area Soil and Groundwater

The selected remedy of bioventing and vacuum vapor extraction satisfies the statutory requirements of CERCLA §121 and CERCLA §120(a)(4), as amended by SARA, in that the following mandates are attained:

- The selected remedy is protective of human health and the environment.
- The selected remedy complies with federal and state requirements that are applicable or relevant and appropriate to the remedial action.
- The selected remedy is cost effective.
- The selected remedy utilizes permanent solutions and alternative treatment technologies or resource recovery technologies, to the maximum extent practicable.
- The selected remedy satisfies the preference for treatment that reduces toxicity, mobility, and/or volume as a principal element.

The following sections describe how the selected remedy satisfies each of the statutory requirements described above.

2.10.4.1 Protection of Human Health and the Environment. There are no current or potential future exposure pathways for this site. However, diesel-related compounds in the soil are above the State-recommended cleanup level of 100 mg/kg for TPH. Therefore, the objective for remediating soil at the Diesel Spill Area is to reduce TPH concentrations to the state cleanup level of 100 mg/kg. As discussed in Section 2.8.1.4, the groundwater remediation objective for this site is, based upon SWRCB Resolution No. 92-49, to restore groundwater to background concentrations. Therefore, the selected remedy will attempt to reduce TPH-diesel concentrations in groundwater to background levels.

Section 2.8.5 discussed the short-term effectiveness of the evaluated alternatives. The selected remedy will not pose unacceptable short-term risks to human health or to environment during implementation.

2.10.4.2 Compliance with Applicable or Relevant and Appropriate Requirements. The selected remedy of bioventing and vacuum vapor extraction will comply with all applicable or

relevant and appropriate chemical-, action-, and location-specific ARARs. The ARARs are presented below.

Chemical-Specific ARARs. None.

Location-Specific ARARs. None.

Action-Specific ARARs.

California requirements for discharges of waste to land in 23 CCR, Div. 3, Chapter 15, §2500 et seq.

California requirements for hazardous waste management in 22 CCR, Div. 4, Chapter 30, §66001 et seq.

California requirements for occupational health and safety in Labor Code, Div. 5, §6300 et seq., and 29 USC §§651-678, respectively.

Selected provisions of the Porter-Cologne Water Quality Act (California Water Code).

Regional Water Quality Objectives in the Water Quality Control Plan ("Basin Plan") for the Lahontan RWQCB.

Requirements for investigation, cleanup, and abatement of discharges in SWRCB Resolution No. 92-49. Application of this ARAR is discussed in Section 2.8.1.4. The SNARL for diesel (μg/l) is used as the basis for the protective water quality objective and is a TBC.

Other Criteria, Advisories, or Guidance To Be Considered for this Remedial Action (TBCs). DTSC has recommended that TPH concentrations in soil at the Diesel Spill Area be reduced to below the 100 mg/kg cleanup level. The selected remedy, when complete, will have reduced the concentrations of soil contaminants to the cleanup level for TPH. The SNARL for diesel (100 μg/l) is used as the basis for the protective water quality objective and is a TBC.

2.10.4.3 Cost Effectiveness. As discussed previously, Alternatives 3, 4, 5, and 6 are equally effective. In addition, these alternatives satisfy the regulatory preference for active treatment, when practicable (see 40 CFR 300.430 (a)(1)(iii)(A)). Since the selected remedy costs less than the pump-and-treat alternatives (Alternatives 3 and 4), and costs only slightly more than Alternative 5, this remedy is considered cost effective. The Army prefers Alternative 6 over Alternative 5 because vacuum vapor extraction is an innovative technology that would have applications at other sites if the performance can be demonstrated.

2.10.4.4 Utilization of Permanent Solutions and Alternative Treatment (or Resource Recovery) Technologies to the Maximum Extent Practicable. Figure 2-37 summarizes the detailed analysis of the alternatives with respect to the CERCLA-mandated evaluation criteria and identifies the major trade-offs of the selected remedy. The selected remedy, Alternative 3,

by actively treating the soil and groundwater, satisfies the statutory preference to utilize permanent solutions and treatment technologies to the maximum extent practicable.

2.10.4.5 Preference for Treatment as a Principal Element. The selected remedy employs active treatment of the soil to reduce soil and groundwater contaminant concentrations below target cleanup levels. Therefore, the CERCLA preference for treatment is satisfied by the selected remedy.

2.10.5 Five Remaining Sites

The maximum concentrations of chemicals detected at the five remaining sites do not pose potential risks to human health and the environment and represent natural conditions. Therefore, no remedial actions are necessary to ensure protection of human health and the environment (CERCLA §121). Because no remedial actions are necessary, no statutory determinations of remedial actions are necessary.

2.11 DOCUMENTATION OF SIGNIFICANT CHANGES

The proposed plan for the seven sites was released for public comment in June 1994. The proposed plan identified the following alternatives as the preferred alternatives for the TNT Leaching Beds Area and Diesel Spill Area:

<u>Paint Shop Subsite Soil</u>

Alternative 3 - Excavation and Off-site Treatment/Disposal

<u>TNT Leaching Beds Subsite Soil</u>

Alternative 3 - Excavation and On-site Composting

<u>TNT Leaching Beds Area Groundwater</u>

Alternative 2 - Natural Attenuation and Degradation

<u>Diesel Spill Area Soil and Groundwater</u>

Alternative 6 - Bioventing and Vacuum Vapor Extraction

Based on the absence of any new information or public comments during the public comment period, it was determined that no significant changes to the selected remedies outlined in the proposed plan were necessary.

3.0 RESPONSIVENESS SUMMARY

The public comment period for the proposed plan at the seven sites at Sierra Army Depot, began on June 1, 1994 and expired on June 30, 1994 without any written comments being received by the Army or regulatory agencies. The public meeting presenting the proposed plan occurred on June 7, 1994. Oral comments were received during the public meeting. A meeting report describing the items presented during the public meeting, oral comments received, and oral responses to comments during the meeting, has been made part of the Administrative Record. The Army's formal responses to the oral comments received during the public meeting are presented below.

1. Comment: Mr. Frank Hinman stated that he thought that the Unidentified Pit had been used in the past as a secondary disposal area of munitions detonations while "the Hill" (Upper Burning Ground) was closed. He also indicated that Mr. Bill Montgomery, Sierra Army Depot, be contacted for further information, since Mr. Montgomery was familiar with munitions operations at the installation.

   Army Response: Mr. Bill Montgomery had been interviewed by representatives of the Army (Harding Lawson Associates) in March of 1992 during preparation of the Group III Remedial Investigation work plans. Mr. Montgomery was aware that the Lower Burning Ground, another Group III site, was used as an alternative disposal area for munitions disposal while the Upper Burning Ground was closed for renovation (1960 to 1961). Mr. Montgomery had no information regarding the existence, or use, of the Unidentified Pit.

2. Comment: Mr. Frank Hinman stated that he had worked at Sierra Army Depot from 1951 to 1978. He recalled that the site referred to as "the Old Fire-Fighting Training Facility" had in the past been use as an ice skating rink but did not recall its use for fire fighting. Mr. Hinman noted that the only fire-fighting training area he was aware of was at a site north of the Security Office.

   Army Response: There are no historical data available documenting that fire-fighting activities were performed at the Old Fire-Fighting Training Facility. In a 1992 interview, Mr. Tracey Totten, Sierra Army Depot Engineering and Planning Division, indicated that a train station was present at the site but had burned down.

   The Existing Fire-Fighting Training Facility, located north of the Security Office and west of Chewing Gum Road, was studied as part of the Group II remedial investigation. A remedial action for cleanup of diesel-contaminated soil is currently being conducted at the site.

3. Comment: Mr. Frank Hinman asked if there was a correlation between the Honey Lake project and groundwater contamination beneath Sierra Army Depot.

Army Response: Based on recent decisions by the Department of Interior, Bureau of Land Management, the Fish Springs Ranch project is not a viable project. Furthermore, off-site pumping may change the groundwater gradient and velocity at the TNT Leaching Beds Area. However, based on groundwater modeling results, these changes are not expected to significantly affect the natural attenuation and degradation alternative.

4. Comment: Mr. Hinman then stated that effects from the Honey Lake project on groundwater contamination beneath Sierra Army Depot had previously been cited [no specific citation] as an issue in consideration of the Honey Lake project.

   Army Response: The effects of the Honey Lake project are more relevant to groundwater contamination that has migrated off site in the southeastern portion of the Depot than to the groundwater contamination described for the TNT Leaching Beds Area. VOCs have migrated a few hundred feet beyond the depot boundary near the southern corner of the depot. The groundwater contamination beneath the southeastern portion of the Depot will be addressed in future actions and public meetings.

5. Comment: Mr. Frank Hinman expressed concern regarding the movement of polluted groundwater affecting individuals residing near the Depot.

   Army Response: The extent of off-site contamination was limited to a small area near the southeastern corner of the Depot. An interim remedial action is planned to control contaminant movement.

6. Comment: Mr. Hinman then indicated that a friend of his had requested information from Sierra Army Depot regarding groundwater contamination but had not received a reply.

   Army Response: The individual seeking information should contact Mr. Larry Rogers, the Public Affairs Officer for SIAD. Mr. Rogers will provide the requested information.

7. Comment: Mr. Frank Hinman asked how fast contaminated groundwater was moving off-site.

   Army Response: Due to a relatively flat groundwater gradient, groundwater in the area is moving relatively slowly. The chemical contamination moves at a rate that is several times slower than the rate of groundwater movement due to interaction with the aquifer soils.

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